[Established 1832]
THE OLDEST RAILROAD JOURNAL IN THE WORLD.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY
BY

R. M. VAN ARSDALE (Inc.)
J. S. BONSALL, VICE-PRES. AND GEN'L MANAGER
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R. V. WRIGHT, E. A. AVERILL, Editors.

JANUARY, 1910

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had been anticipated in so short a time, even by the most enthusiastic supporters of the scheme.

These few items, noted not because they cover the field, but rather because they have been drawn to the attention of the editors in one form or another within the past few days, are an indication of how the railroads in general feel about these questions and indicate the direction in which the current is flowing. They give a promise of greater efficiency among the railroad employees and the upbuilding of a spirit of loyalty and co-operation that will mean much from an economic standpoint in the years to follow.

A STITCH IN TIME.

Weather of the character that swept practically the whole country during the latter part of the last month brings the value of first-class locomotive terminal facilities forcibly to the attention of every official and indeed to every patron of our railroads. It is at such a time that the millions invested in first-class structures and equipment return a very high rate of interest and it is for coping with just such periods of great difficulty in operation that locomotive terminals should be designed in every detail.

In this issue appears the first part of an extensive discussion of this subject, which will be continued in the two following numbers. This seems to be a very opportune time for bringing this matter up for discussion and it is to be hoped that a practical improvement will follow its agitation.

Under severe winter conditions which have to be met, usually for several months, in the northern section of the United States, which includes a very large proportion of the total mileage of the country, the locomotive terminal facilities are in reality the keystone of the complicated structure of railroad operation and any looseness at this point affects the stability of the whole structure. In view of this it is easily recognized that roundhouses, cinder pits, intercommunicating facilities, etc., should all be designed so as to successfully meet the worst possible conditions, although they may be put to the supreme test for but a few weeks out of the whole year. Yet it is in those few weeks that their value will be large enough to pay interest on the investment for the whole period. At times when schedules are thoroughly disarranged, tonnage is reduced, the efficiency of the personnel of both shop and road are reduced, derailments are numerous and nerves are frayed, *then* a smooth working, competent roundhouse organization provided with suitable tools, proper protection and convenient arrangement, is worth anything it may cost, no matter how large.

This whole subject should also be seriously considered at this time when appearances indicate that the articulated type of locomotive will become more or less common. It will be remembered how much confusion was caused at division terminals when the Pacific type engines were first introduced and how the whole scheme of terminal operation was handicapped by their very large size and great length. That experience will be duplicated in a much more aggravated form if the Mallets become common and careful consideration of this possibility should be given in connection with the redesign of any division points.

The second principle advanced for the most successful conduct of a motive power department in the June, 1909, issue was, "Establish a standard cost or allowance for each of the various items of expenditure and see that it is not exceeded." This principle applies to the expenditure for fuel fully as much as it does to any other item and elsewhere in this issue are given two very complete discussions of the theoretically and practically possible limits of fuel consumption. There are probably none better fitted to speak on this subject than the authors of these papers and the information contained therein will undoubtedly be found to be of great value for establishing a satisfactory new standard or checking up the present one.

EDUCATIONAL BUREAU OF INFORMATION.

UNION PACIFIC RAILROAD.

An outline of the work of the educational bureau of information, recently established on the Union Pacific Railroad, appeared in the October, 1909, number of this journal. In discussing this matter at the fourth annual meeting of the operating officials, D. C. Buell, chief of the bureau, explained the work of the bureau in greater detail. Following is an abstract of his remarks:

Assisting Employees to Assume Greater Responsibilities.

All practical railroad men realize that much of their work is governed by what may be termed unwritten laws. Few books are published that give practical information of value concerning it, and many employees are so situated that it is impossible under present conditions to acquire a working knowledge that will fit them to assume greater responsibilities. You gentlemen have had the perseverance to work out your own betterment; have used your eyes, ears and brains to learn all you could of the reasons for doing things that were going on around you daily, and by your fitness have overcome your difficulties and risen to your present official positions, but who can tell how much hardship and how many mistakes might have been avoided had you had the opportunity to learn much of this unwritten law, gleaned from the experience of, and put in practical form by, those who had "gone through the mill" before you.

It is the purpose of this bureau in its first object to furnish courses of reading and study especially prepared under the direction of the advisory board to cover as much of this so-called unwritten law as possible and to combine with it such existing instructions and written matter as will assist an employee to assume greater responsibilities in the line of his work, the course to be conducted somewhat on the method of now existing correspondence schools.

The privilege of taking a course of this kind is offered to all employees. The bureau will offer any employee desiring to qualify himself to assume greater responsibilities, a course of reading and study along the line that he may indicate. This course need not necessarily be confined to the particular work of the department with which the employee is connected, but may embrace any subject, the knowledge of which may be of value to the employee in the position now occupied or that will help to qualify the employee to change positions to a line of work which would be more nearly suited to the ambition or desire. This statement was made broad enough so that no employee need hesitate to state what he wanted the bureau to do for him or what line of work he was ambitious to master. Certain reasonable qualifications, however, are implied, and these are concisely set forth as follows:

Firemen, until they have passed promotion examinations in rules, air brake and machinery, will be assisted only on matters pertaining to the knowledge necessary to pass these promotion examinations.

Brakemen, switchmen, etc., until they have passed all promotion examinations for conductors, yard foremen, etc., will be assisted only by answers to such questions as they may ask the information bureau, although we do not limit the number of questions they may ask. An exception to this will be made in the case of brakemen having had three years experience, or more, one year at least of which has been served on the Union Pacific Railroad, in which case an advanced course may be taken up with the permission of the general superintendent.

Stenographers, clerks, etc., will be allowed to take up studies pertaining to the department in which they work as long as they are not of too advanced a character, and in special cases where they are anxious to get into a different line of work they may be allowed to take up a study of work in other departments, by the approval of the general superintendent.

It is not the intention to teach elementary or rudimentary subjects, such as arithmetic, writing, spelling, grammar, etc., which are taught in ordinary night schools or business colleges, except in certain particular cases, such as shop classes for apprentices,

or where an employee is located at such a point that there is no other way for him to get this training, and the training of this man in the particular subject would be of benefit to the company.

In planning the different courses now in preparation it was thought best to require each student to familiarize himself with the history of the Union Pacific, its geography and resources, and to also give an outline of the federal and state laws that affect the road. In all cases this will probably be the first work of the different courses.

Courses are now being prepared on the maintenance of automatic block signals, mechanical engineering as applied to railroad work, track work in both English and Japanese, station work, freight traffic, accounting, railroad operation, electric lighting and power, questions and answers for firemen studying for promotion examinations in machinery.

Additional courses planned are: Gasoline motor car work, analysis of statistics, maintenance of interlocking plants and their construction, car building, shop practice, civil engineering as applied to railroad work, refrigeration.

The courses now being prepared all start with the elementary work and lead up step by step so as to give a general practical knowledge of the subject. Students assigned to these courses will be started on the first work and while it will be in the nature of a review for some of them, it is hoped they will all profit to some extent by a study of this elementary work, thus insuring a thorough knowledge of the subject as they progress, and that they will have patience with the bureau until the more advanced work can be gotten out. The first work was sent out about November 1st.

Where special courses are asked for, the applications will be considered by the advisory board and the course furnished, if practical, at as early a date as possible. The lessons will be sent out to students in two forms. First: Lessons that have been specially prepared by the bureau will be mimeographed on standard letter-size paper with cloth binding, and the student may keep these. Second: Instructional matter to be studied from books already printed will be outlined, showing just what parts of the printed work must be mastered, and this outline sent to the student with the book. These books will simply be loaned to the student, and he will be held responsible for their safe return, and in case of failure to return them, they will be charged against him at cost price. The books may be kept a reasonable time, the student being notified as to when he should return them. An extension of time will be allowed for good cause.

A set of questions will be sent with each lesson. Written answers must be submitted and show a satisfactory understanding of the work before additional lessons will be furnished. Students must show interest in their work by doing a reasonable amount of studying. They will not be crowded, but lapses of several months without reasonable excuse will be considered sufficient grounds for dropping them from the student rolls.

Applications from employees are numbered consecutively as received and a blank form sent out to be filled in with information as to the education and practical experience of the applicant, together with a statement as to whether he has made a special study of any subject, is a subscriber to any technical magazine, or a student of a correspondence school. He is also asked to state what he desires the bureau to do for him, the information he wants, what line of work he wants to advance in, and what (in reason) he is ambitious to become. This application, when complete, is considered by the advisory board, and if the information requested is of the proper sort, the course is assigned. If, however, the request is such that any of the qualifications above noted are in effect, then further correspondence is had with the applicant until something can be assigned that is satisfactory to both the applicant and the advisory board.

Men selected for advancement to minor official positions will be afforded an opportunity, before formal appointment is made, of acquiring a knowledge of the practical workings of such departments as they have not been intimately connected with, through a temporary connection therewith under the direction of the heads of such departments, and at a salary fixed by the board of supervisors. Complete records will be kept of the student work done by employees.

Increasing the Knowledge and Efficiency of Employees.

Rarely a day passes in the course of a busy man's career but that some question comes to his mind about which he would like information. The majority of such questions, however, go unanswered unless some pressing necessity makes it imperative that time be taken to obtain the answer. Workmen hesitate to ask too many questions of their foremen; foremen let some point go rather than to show their lack of knowledge and some officials even clothe their lack of knowledge on occasional points in the mantle of reserve rather than to risk their official dignity by asking a question of a subordinate who assumes their knowledge to be universal. Many questions that are asked are answered in such a way that the questioner does not understand the point clearly and rather than to appear dull or slow, the matter will often be dropped.

It is the purpose of this bureau in its second object to provide a means whereby any employee desiring information on any particular question or problem met with from day to day, can send this question to the bureau for an answer. There is no formality connected with this matter; all that is necessary is to write the question and mail it to the bureau, giving name and address where employed, also position or occupation. The information will be furnished through the bureau in a simple and practical manner and as promptly as possible. The bureau will have its own telegraph office and officials can get information direct by wire, using cipher code if desirable.

Questions, when received, are copied and referred to the member of the advisory board best qualified to answer them, it being the intention to have all inquiries answered in such a manner that they will in nowise conflict with the instructions, ideas or precedents of the department to which they relate. The answers are held and passed on by the advisory board at the first meeting and are then sent to the questioner. It is not the intention to have questions requiring the official ruling of some particular person sent to the bureau, but if such questions are received it is the intention to handle them through the bureau, having the proper member of the advisory board send them to the proper official for a ruling, after which they are returned to the bureau. In cases of this kind the questioner, when his answer is returned, will be requested to refer such matters through the regular channels in the future.

All questions are handled impersonally; the name of the questioner is not shown on the question when it is passed to the advisory board member for handling, only the questioner's occupation being given; nor is the name of the advisory board member furnishing the answer shown. No limit is set on the number of questions that may be asked and an employee may ask for information every day if he so desires. A record is kept of all answers, catalogued for easy reference, and a card catalogue shows which of the employees are taking advantage of this branch of the bureau.

Preparing Prospective Employees for the Service.

The promotion of desirable men and the elimination of undesirables creates a constant demand for new material throughout the organization. The demand is perhaps greatest for station helpers, signal men, operators, freight house men, agents, clerks, brakemen, common laborers.

It is the purpose of this bureau to assist in supplying men of good reputation and character for vacancies of this order, and where possible to train these men as far as practical in the duties of their prospective work before their employment. To this end, applications for employment will be received, preference in all cases being given to dependents or relatives of employees. The personal history of all applicants will be obtained, references investigated, and each applicant required to take a physical examination to assure us that he can pass our requirements, if his record is satisfactory and we wish to employ him. The names of all available applicants will be kept on file at the bureau and any official wishing help can apply to the bureau for it. If satisfactory material is on hand it will be furnished immediately.

The bureau, however, will not solicit positions for applicants; requests will have to come from the general organization if its assistance is desired, and the interest of the bureau in the men furnished ceases when they are employed, unless later they take advantage of the privilege of the information or educational features. Applications of experienced railroad men, when received, will also be looked up and their names placed on file, although it is hoped that all positions suitable for men of this class can be filled from our own ranks.

The names of student employees making marked progress in their studies will be placed before the general superintendent for his information, and it is hoped that in this way men available for promotion will have a better chance to connect with vacancies that they may be qualified to fill, and thus the necesssity for going outside our ranks to fill such positions be still further reduced. Where practical to do so, the elementary lessons of suitable courses may be sent to applicants whom we think we will have use for in the future, so that they can be preparing themselves to give better service when employed.

In addition to the foregoing, there will be established under this third object, schools at the Bureau's offices, for the preparation of student operators, brakemen and signal service men by personal instruction. Students of telegraph schools preparing for positions as student operators will, on graduation from their course in telegraphy, be brought to Omaha and put through a course of training of from two to four weeks in a model local station fitted for this work. This station will be equipped with the regular local station furniture and forms, wires will be cut into an operator's table; tariffs, tickets, baggage checks, time cards, etc., will be used to familiarize these students with the actual work they will have to do when they go in service, and an instructor will direct their work and see that they have the knowledge necessary to give satisfactory service before they are sent out.

The training of applicants for positions as brakemen is a more difficult proposition, but it is hoped that men can be taught the operating and block signal rules, the signals, how to pack hot boxes, and care for their markers and lanterns. In addition to this, and probably most important, there will be instilled into them the knowledge that honesty, sobriety, careful attention to duty and the observance of all rules and regulations will assure them of a steady job and the right to hope for future promotion.

The training of applicants for positions in the signal department will be accomplished by actual work on batteries and signal appliances, installed as a part of the school's equipment, and while this school in these branches will be experimental, there is reason to hope that the experiment will be a success, as proved by better material furnished due to its establishment.

THE UTILIZATION OF FUEL IN LOCOMOTIVE PRACTICE.*

By W. F. M. Goss.

INTRODUCTION.

The locomotives in service on the railroads of this country consume more than one-fifth of the total coal production of the United States. The amount is so large that any small saving that can be made effective in locomotive practice at once becomes an important factor in conserving the fuel supply of the nation. For this reason the United States Geological Survey has given attention to the special problems of combustion in locomotive boilers. It has approached this task from several different directions. The facts presented herewith constitute one series of results.

In the fall of 1906 the locomotive-testing laboratory of Purdue University, at Lafayette, Ind., entered on a series of tests, one purpose of which was to determine in precise terms the degree of efficiency with which a modern high-class American locomotive utilizes the heat energy of the fuel supplied to it. The general interest in the subject, the elaborate plans which had been formulated for conducting the work, and the substantial character of the support which had been pledged to maintain it justified the Geological Survey in aiding the investigation. The co-operation of the Survey consisted in detailing experts to assist the regular staff of the laboratory in the chemical and calorific work of the tests. These experts, working under the general supervision of the director of the Purdue laboratory, became responsible for the sampling of smoke-box gases, of the fuel used, of the cinders caught in the front end, of the sparks discharged by the stack, and of the refuse caught in the ash pan. The gas analyses were made by them at the university laboratory. The analyses of all solid samples and the calorific tests of the fuels were made at the government fuel-testing plant at St. Louis. The representatives of the Survey were not concerned with other phases of the work.

The locomotive used in the experiments is a simple superheating locomotive of the American type, with a boiler designed to operate under pressures as high as 250 pounds. The superheater is of the return-tube type and was built and installed in the summer of 1906.

Some of the principal characteristics of the locomotive are as follows:

Total weight	109,000 lbs.
Weight on four drivers	61,000 lbs.
Cylinders:	
Diameter	16 in.
Stroke	24 in.
Drivers, diameter outside of tire	69¼ in.
Boiler:	
Type	Extended wagon top
Length of firebox	72 1/16 in.
Width of firebox	34½ in.
Depth of firebox	79 in.
Number of 2-inch tubes	111
Number of 5-inch tubes	16
Length of tubes	11½ ft.
Heating surface in firebox	126 sq. ft.
Heating surface in tubes, water side	897 sq. ft.
Total water-heating surface, including water side of tubes	1,023 sq. ft.
Superheater:	
Type	Cole return tube
Outside diameter of superheater tubes	1¼ in.
Number of loops	32
Average length of tube per loop	17.27 ft.
Total superheating surface based upon outside surface of tubes,	193 sq. ft.
Total water and superheating surface, including water side of boiler tubes	1,216 sq. ft.

The purpose of the tests was to determine the performance of the boiler and superheater of a normal locomotive while developing such rates of power as are common in locomotive service. The process involved a careful study of the various channels through which the heat energy of the fuel is absorbed or dissipated.

The results represent work done with two grades of coal that will be designated as coal A and coal B. Both are of excellent quality. The greater part of the tests were run with coal A, which, for purposes of discussion, will be regarded as the standard for the tests. The chemical characteristics and the calorific value of samples taken from the fuel of each test are summarized in the following table:

	Coal A.	Coal B.
Moisture, per cent.	1.89	3.10
Volatile matter, per cent.	31.94	15.23
Fixed carbon, per cent.	57.71	72.75
Ash, per cent.	8.46	8.92
Heating value per pound of dry coal B.t.u.	14,047	14,347
Heating value per pound of combustible, B.t.u.	15,372	15,802

HEAT BALANCES.

Heat balances representing the action of locomotive boilers have justly been regarded as difficult to formulate. In the present tests efforts were made to procure complete data on which such a balance could be based. The data making up these balances are presented in Figure 1, but can be most easily understood by reference to Figures 2 and 3, which show the results obtained with coal A and coal B, respectively. It is the purpose of the heat balance, as the term implies, to account for all heat represented by the coal supplied to the fire box, not only the heat which is utilized, but that which is lost, and to point out the various channels through which losses occur. In the diagrams the term "heating surface," as applied to the abscissas, includes the heat-transmitting surface of both boiler and super-

* Extracts from Bulletin No. 402, U. S. Geological Survey.

No. of test.	Laboratory designation.	Calorific value (British thermal units per pound of combustible).	British thermal units absorbed per pound of combustible fired.	British thermal units lost per pound of combustible fired.									Percentage of heat—									
				Due to H_2O in coal.	Due to H_2O in air.	Due to H_2O formed by H in coal.	Due to escaping gases.	Due to incomplete combustion.	Due to front-end cinders.	Due to stack cinders.	Due to refuse in ash pan.	Unaccounted for.	Absorbed by boiler and superheater.	Due to H_2O in coal.	Due to H_2O in air.	Due to H_2O formed by H in coal.	Due to escaping gases.	Due to incomplete combustion.	Due to front end cinders.	Due to stack cinders.	Due to refuse in ash pan.	Unaccounted for.
1	2	85	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108
1	30-5-240......	15,388	9,040	24	70	632	1,975	576	1,235	141	639	1,056	58.75	0.16	0.46	4.11	12.83	3.74	8.02	0.92	4.15	6.86
2	40-4-240......	15,416	9,136	24	33	625	2,057	565	1,224	147	537	1,068	59.28	.15	.20	4.05	13.35	3.67	7.94	.95	3.48	6.93
3	30-4-240......	15,398	9,252	25	82	633	2,049	451	886	137	933	950	60.08	.16	.53	4.11	13.31	2.93	5.75	.89	6.06	6.17
4	30-2-240......	15,352	10,189	41	39	688	2,087	72	432	205	634	965	66.37	.27	.25	4.48	13.58	.47	2.81	1.34	4.13	6.30
5	40-6-200......	15,566	9,832	28	62	649	2,325	243	918	173	588	748	63.16	.18	.40	4.17	14.93	1.56	5.00	1.11	3.78	4.81
*6	50-4-200......	15,744	8,489	34	55	544	2,133	66	1,882	284	823	1,434	53.90	.22	.35	3.45	13.32	.42	11.96	1.80	5.23	9.37
7	40-4-200......	15,214	9,330	29	75	671	1,801	746	750	206	895	711	61.34	.19	.49	4.41	18.86	4.90	4.95	1.35	5.88	4.63
8	30-6-200......	15,332	9,552	23	47	637	2,297	167	625	124	785	1,075	62.34	.15	.31	4.16	14.98	1.09	4.08	.81	5.12	6.96
*9	30-2-200......	15,875	10,430	56	58	541	2,392	8	670	243	738	739	65.70	.35	.37	3.41	15.07	.05	4.22	1.53	4.65	4.65
10	30-8-160......	15,425	10,209	25	42	653	2,342	195	561	112	570	716	66.16	.16	.27	4.24	15.18	1.27	3.64	.73	3.70	4.65
11	40-6-160......	15,351	10,170	34	42	646	2,272	229	463	205	604	686	66.25	.22	.27	4.21	14.79	1.49	3.02	1.33	3.93	4.49
12	30-4-160......	15,300	10,575	28	57	581	2,160	194	178	152	573	802	69.12	.18	.37	3.80	14.11	1.27	1.16	.99	3.74	5.26
*13	40-12-120.....	15,857	7,408	45	55	556	2,217	199	2,654	596	445	1,680	46.72	.28	.35	3.51	13.98	1.26	16.74	3.76	2.81	10.59
*14	30-14-120.....	15,714	7,456	54	44	568	2,272	122	2,373	817	446	1,562	47.45	.34	.28	3.61	14.46	.78	15.10	5.20	2.84	9.94
*15	30-10-120.....	15,799	8,480	43	43	547	2,178	116	1,910	326	948	1,208	53.67	.27	.27	3.46	13.78	.73	12.09	2.06	6.00	7.67
*16	40-8-120.....	15,752	9,446	42	44	538	2,294	30	1,233	320	665	1,140	59.97	.26	.27	3.42	14.56	.19	7.82	2.03	4.22	7.26
17	30-8-120......	15,348	10,701	34	59	597	2,239	130	270	132	439	747	69.73	.22	.38	3.89	14.58	.85	1.76	.86	2.86	4.87
*18	40-4-120......	15,872	10,817	55	46	486	2,145	89	400	174	807	833	68.14	.35	.29	3.06	13.58	.56	2.52	1.10	5.09	5.31

FIG. I.

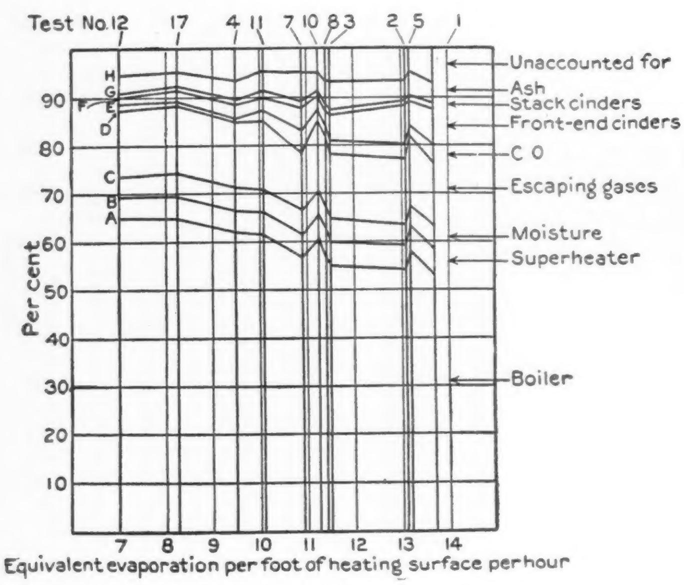


FIG. 2.—RESULTS OBTAINED WITH COAL A.

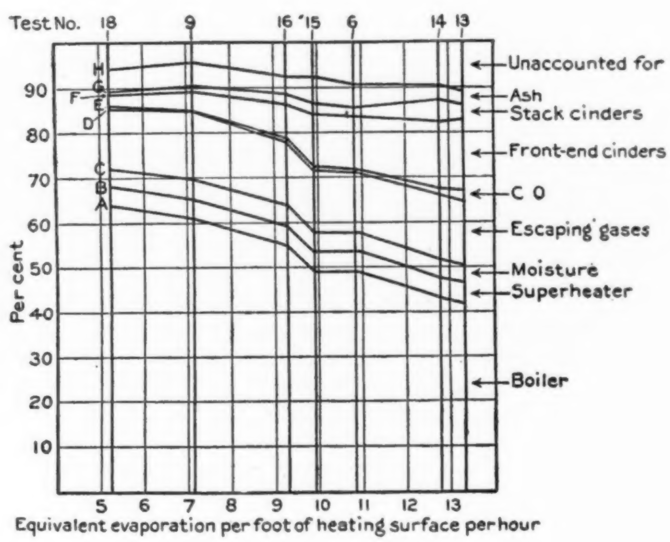


FIG. 3.—RESULTS OBTAINED WITH COAL B.

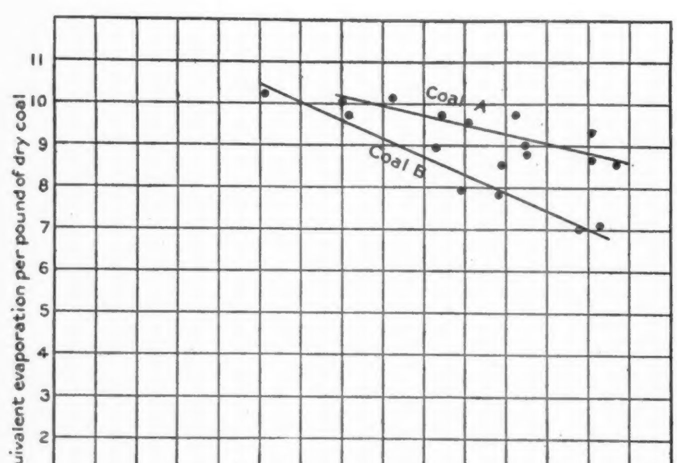


FIG. 4.

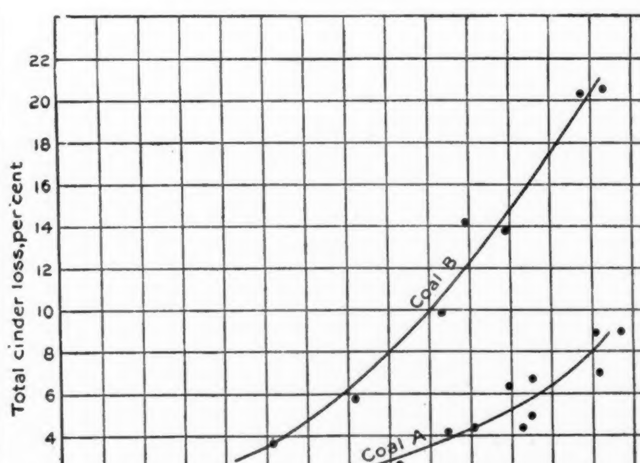


FIG. 5.

heater. The ordinates of the diagrams represent the percentage of heat in the fuel supplied. Distances measured on ordinates between the axis and the first broken line, A, represent the percentage of the total heat supplied which is absorbed by the water of the boiler. The line A is, in fact, a definition of the efficiency of the boiler under the varying rates of evaporation represented by the tests. Though based on a different unit, it is, as it ought to be, similar in general form to the lines defining the evaporative efficiency of the boiler in terms of pounds of water evaporated per pound of coal used (Fig. 4). The inclination of all such lines shows the extent to which the efficiency of the boiler suffers as the rate of evaporation is increased. The nature and extent of the losses leading to decreased efficiency are to be found in the areas above the line A. The fact that the points representing different tests through which this line is drawn do not result in a smooth curve is due to irregularities in furnace conditions that were beyond the vigilance of the operator, an explanation which applies equally to other lines of the same diagram. Again, where the points on which the line A is based fail to form a smooth curve, the reason therefor is to be found in the location of the lines above.

The percentage of the total heat which is absorbed by the superheater is measured by distances on ordinates between lines A and B. It is apparent that this quantity is practically constant, whatever may be the power to which the boiler is driven; that is, this superheater is a device of constant efficiency. The normal maximum power of a locomotive may for present purposes be taken as represented by an evaporation of 12 pounds of water per square foot of heating surface per hour. At this rate the superheater, which contains 16 per cent. of the total heat-transmitting surface, receives approximately 8 per cent. of the total heat absorbed. Distances between the broken line B and the axis represent the efficiency of the combined boiler and superheater, and distances above the line B account for the various heat losses incident to the operation of the furnace, boiler, and superheater.

Losses of heat arising from the presence of accidental and combined moisture in the fuel, of moisture in the atmospheric air admitted to the fire box, and of moisture resulting from the decomposition of hydrogen in the coal are represented by distances measured on ordinates between lines B and C. It is of passing interest to note that the heat thus accounted for is practically equal to that absorbed by the superheater.

Losses of heat in gases discharged from the stack are represented by distances measured on ordinates between lines C and E. The distances between lines D and E represent that portion of these losses which is due to the incomplete burning of the combustible gases. The record shows that the stack loss (C-E), while necessarily large, increases with increased rates of combustion far less rapidly than has been commonly supposed. In other words, the loss in evaporative efficiency with increase of power (line B, Figs. 2 and 3) occurs only to a very slight degree through increase in the amount of heat carried away with the smoke-box gases. That portion of this loss which is chargeable to incomplete combustion (CO) is small under low rates of combustion (Column 104, Fig. 1), but may increase to amounts of some significance under the influence of very high rates of combustion, as will be seen from the record of coal A.

Losses of heat through the discharge from the fire box of unconsumed fuel are represented by distances measured on ordinates between lines E and H. The loss thus defined is separated into three parts—the heat loss by partly consumed fuel in the form of cinders collecting in the front end (E-F), the heat loss by partly consumed fuel in the form of cinders or sparks thrown out of the stack (F-G), and the heat lost by partly burned fuel dropping through the grate into the ash pan (G-H). The first two of these losses increase with the rate of power developed. They are, in fact, the chief cause of the decrease in the evaporative efficiency of a locomotive boiler with increased rates of power. This is well shown by a comparison of the two diagrams. In the tests with coal B (Fig. 4) the cinder loss is comparatively heavy and the boiler efficiency diminishes in a marked degree under high rates of power, while tests under similar conditions with coal A (Fig. 2), involving less loss by cinders, show an efficiency of the boiler under high rates of power which is much better sustained.

The cinder loss expressed as a percentage of the total weight of coal fired is shown by Figure 5, and the heating value of the material thus accounted for by Figure 6. It will be seen that cinders from coal B have more than double the weight and that each pound has nearly double the heating value of those from coal A, a result doubtless due in part to the large percentage of fine material in coal B and to the absence of such material in coal A. The stack cinders from both coals have a higher calorific value than those caught in the smoke box. Under the practice of the laboratory, the coal was not wetted previous to being fired. Concerning the general significance of the cinder loss as recorded here, it should be remembered that the fuel used in all the tests was of high quality. Lighter and more friable coals are as a rule more prolific producers of stack and front-end cinders.

Radiation, leakage, and all losses not previously accounted for are represented by the distance on ordinates between line H and the 100 per cent. line of the diagrams. Radiation losses are probably not much in excess of 1 per cent., so that the remainder of this loss—from 3 to 8 per cent. of the total heat available

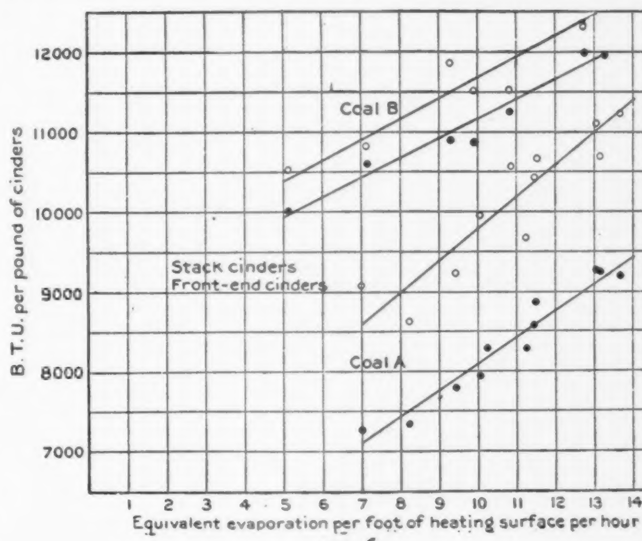


FIG. 6.

—represents leakage of steam or water, or inaccuracy in determining the value of one or more of the quantities already discussed.

DISTRIBUTION OF HEAT IN THE TEST LOCOMOTIVE.

It is sometimes convenient to have an elaborate statement of fact summarized into a few representative figures, the relation between which may be easily apprehended. Such a summary may be framed for the present case by assuming that the normal maximum power of the locomotive tested is that which involves a rate of evaporation of 12 pounds of water per square foot of heating surface per hour, and by averaging from the diagrams (Figs. 2 and 3) the values of the various factors entering into the heat balance for this rate of power. The result may be accepted as showing in general terms the action of such a locomotive as that tested when fired with a good Pennsylvania or West Virginia coal. It is as follows:

AVERAGED HEAT BALANCE FOR TEST LOCOMOTIVE.
[Percentages of total heat available.]

Absorbed by the water in the boiler	52	
Absorbed by steam in the superheater	5	
Absorbed by steam in the boiler and superheater		57
Lost in vaporizing moisture in the coal		5
Lost through the discharge of CO		1
Lost through the high temperature of escaping gases, the products of combustion		14
Lost through unconsumed fuel in the form of front-end cinders		3
Lost through unconsumed fuel in the form of cinders or sparks passed out of the stack		9
Lost through unconsumed fuel in the ash		4
Lost through radiation, leakage of steam and water, etc.		7
		100

General Conclusions.

There were in 1906, on the railroads of the United States, 51,000 locomotives. It is estimated that these locomotives consumed during the year not less than 90,000,000 tons of fuel, which is more than one-fifth of all the coal, anthracite and bituminous, mined in the country during the same period. The coal thus used cost the railroads $170,500,000. That wastes occur in the use of fuel in locomotive service is a matter which is well understood by all who have given serious attention to the subject, and the tests whose results are here presented show some of the channels through which these wastes occur. These results are perhaps more favorable to economy than those attained by the average locomotive of the country, as the coal used in the tests was of superior quality, the type of locomotive employed was better than the average, and the standards observed in the maintenance of the locomotive were more exacting. But the effect on boiler performance arising from these differences is not great and, so far as they apply, the results may be accepted as fairly representative of the general locomotive practice of the country. They apply, however, only when the locomotive is running under constant conditions of operation. They do not include the incidental expenditures of fuel which are involved in the starting of fires, in the switching of engines, and in the maintenance of steam pressure while the locomotive is standing, nor do they include a measure of the heat losses occasioned by the discharge of steam through the safety valve. Observations on several representative railroads have indicated that not less than 20 per cent of the total fuel supplied to locomotives performs no function in moving trains forward. It disappears in the incidental ways just mentioned or remains in the fire box at the end of the run. The fuel consumption accounted for by the heat balance above is, therefore, but 80 per cent. of the total consumed by the average locomotive in service. Applied on this basis to the total consumption of coal for the country, the heat balance may be converted into terms of tons of coal as follows:

Summary of Results Obtained from Fuel Burned in Locomotives.

	Tons.
1. Consumed in starting fires, in moving the locomotive to its train, in backing trains into or out of sidings, in making good safety-valve and leakage losses, and in keeping the locomotive hot while standing (estimated)	18,000,000
2. Utilized, that is, represented by heat transmitted to water to be vaporized	41,040,000
3. Required to evaporate moisture contained by the coal	3,600,000
4. Lost through incomplete combustion of gases	720,000
5. Lost through heat of gases discharged from stack	10,080,000
6. Lost through cinders and sparks	8,640,000
7. Lost through unconsumed fuel in the ash	2,880,000
8. Lost through radiation, leakage of steam and water, etc.	5,040,000
	90,000,000

These amounts, together with the corresponding money value, are set forth graphically by Figure 7. It is apparent from this exhibit that the utilization of fuel in locomotive service is a problem of large proportions, and that if even a small saving could be made by all or a large proportion of the locomotives of the country it would constitute an important factor in the conservation of the nation's fuel supply. On examining the diagram with reference to such a possibility the following facts are to be noted: The amount of fuel consumed in preparing locomotives for their trains, etc. (item 1), is dependent only to a very slight extent on the characteristics of the locomotive, being in large measure controlled by operating conditions, by the length of divisions, and by the promptness with which trains are moved. Under ideal conditions of operation much of the fuel thus used could be saved, and it is reasonable to expect that the normal process of evolution in railroad practice will tend gradually to bring about some reduction in the consumption thus accounted for.

The fuel required to evaporate moisture in the fuel (item 3) and that which is lost through incomplete combustion (item 4) are already small and are not likely to be materially reduced.

The loss represented by the heat of gases discharged from the stack (item 5) offers an attractive field to those who would improve the efficiency of the locomotive boiler. So long as the temperature of the discharged gases is as high as 800° F. or more there is a possibility of utilizing some of this heat by the application of smoke-box superheaters, reheaters, or feed-water heaters, though thus far the development of acceptable devices for the accomplishment of this end has made little progress.

The fuel loss in the form of cinders collecting in the front end and passing out of the stack (item 6) is very large and may readily be reduced. The results here recorded were obtained with a boiler having a narrow fire box; the losses in the form of cinders would probably be smaller with a wide fire box. A sure road to improvement in this direction lies in the direction of increased grate area. Opportunities for incidental savings are to be found in improved flame ways such as are to be procured by the application of brick arches or other devices. Such losses may also be reduced by greater care in the selection of fuel and in the preparation of the fuel for the service in which it is used. It is not unreasonable to expect that the entire loss covered by this item will in time be overcome.

The fuel which is lost by dropping through grates and mingling with the ash (item 7) is a factor that depends on the grate design, on the characteristics of the fuel, but chiefly on the degree of care exercised in managing the fire. More skilful firing would save much of the fuel thus accounted for.

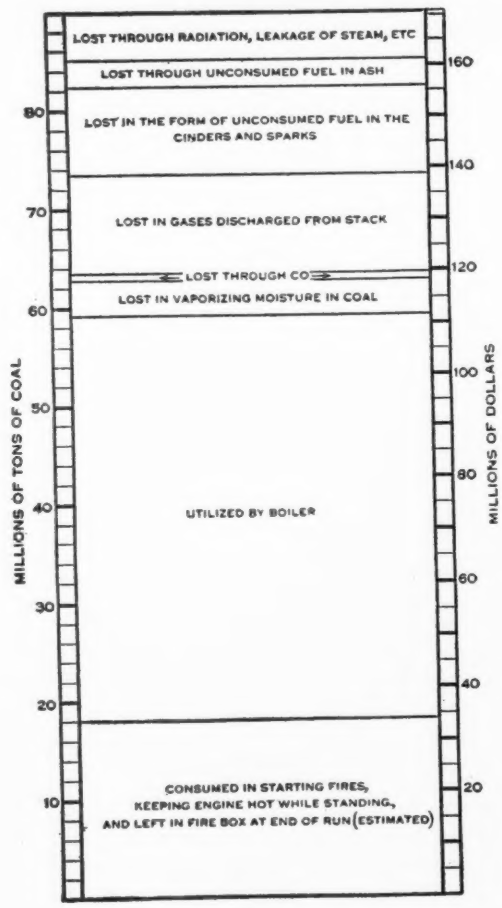
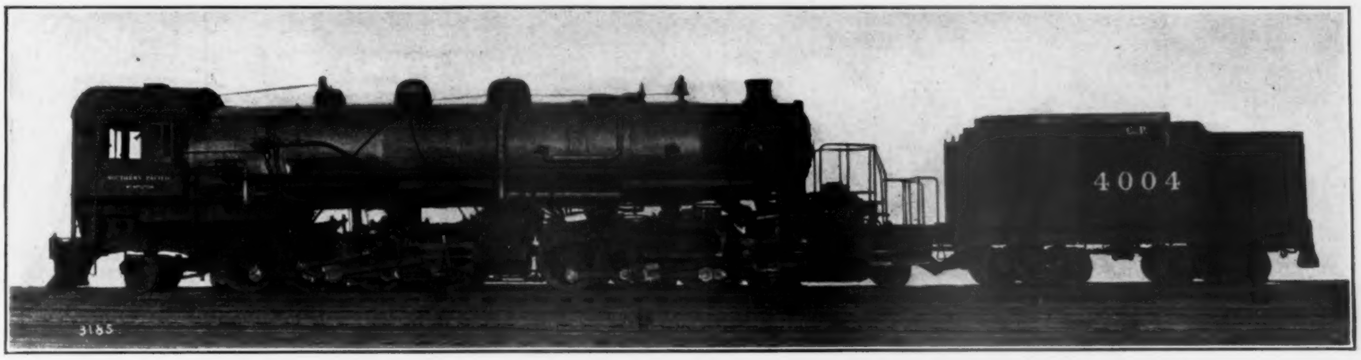


FIG. 7.

The radiation and leakage losses (item 8) may in part be apparent rather than real, owing to possible inaccuracies in the process of developing the heat balance. On the assumption that the values are correct as stated, however, it is not likely that under ordinary conditions of service they can be materially reduced.

Locomotive boilers are handicapped by the requirement that the boiler itself and all its appurtenances must come within rigidly defined limits of space, and by the fact that they are forced to work at very high rates of power. Notwithstanding this handicap, it is apparent that the zone of practicable improvement which lies between present-day results and those which may reasonably be regarded as obtainable is not so wide as to make future progress rapid or easy. Material improvement is less likely to come in large measures as the result of revolutionary changes than as a series of relatively small savings in the several items to which attention has been called.



SOUTHERN PACIFIC ARTICULATED OIL BURNING LOCOMOTIVE WITH CAB AT FRONT END.

ARTICULATED OIL BURNING LOCOMOTIVES WITH CAB AHEAD.

SOUTHERN PACIFIC COMPANY.

It has been suggested a number of times that with oil burning locomotives it would be possible to reverse the customary direction of running and by placing the tender at the other end of the locomotive the engineer could be located where he would have a perfect view ahead without separation from the fireman and leaving him in a position where he could watch the condition of the fire, height of water level, etc. This idea has been put into practice on some of the Italian railways, and, as is

FRONT VIEW OF SOUTHERN PACIFIC ARTICULATED LOCOMOTIVE.

shown in the illustration, is now being inaugurated on sections of the Southern Pacific.

Service with the very large Mallet articulated locomotives, two of which were built by the Baldwin Locomotive Works for this company early in the year, and were fully described and illustrated on page 181 of the May and 367 of the September issues of this journal, soon proved them to be remarkably successful, and this trial order was immediately followed by an order to the same works to build nineteen more of a duplicate pattern. These twenty-one locomotives are distributed on the various Associated Lines as follows: Three to the Union Pacific Railway, arranged for burning coal; three oil burners to the Oregon Railroad and Navigation Company, and fifteen oil burners for the Southern Pacific Company. The last order for oil burners were specified to be arranged with the cab ahead, which decision in this case was largely influenced by the necessity of operating locomotives through tunnels and snow sheds where the gases from the stack were very disagreeable to the crew. This is especially troublesome on these long locomotives where the smoke strikes the top of the tunnel and has time to descend in front of the cab.

In the new design, the cab is entered through side doorways reached by suitable ladders. The cab fittings are conveniently located within easy reach of the engineer, who occupies the right hand side looking ahead. The Ragonnet power reversing gear is the same as on former locomotives, and it is only necessary to run a shaft across the boiler back head in order to make the connection with the operating lever.

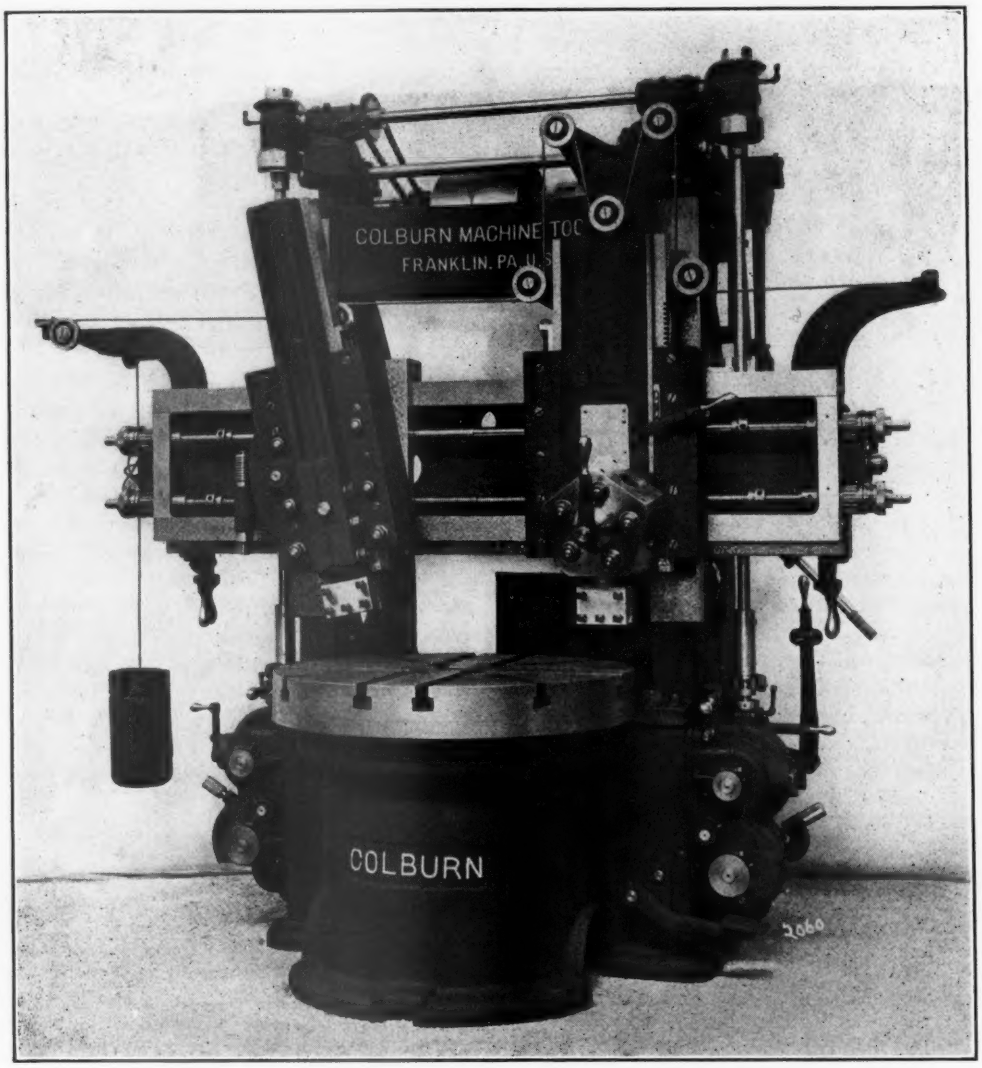
Some slight changes, of course, have been necessary for arranging the bumper beam and pilot at the opposite end of the frames, and of the deck plate at the smoke box end, both of which are of cast steel. The deck plate is provided with a chafing block and a suitable pocket for the tender drawbar and the bumper beam has been located well forward to protect the engine crew from buffing and collision shocks. The tender is of the Associated Lines standard, with a rectangular tank as equipped for oil burning locomotives.

These alterations have made slight changes in the weights, which are as follows:

Weight on drivers	394,150 lbs.
Weight on front truck	14,500 lbs.
Weight on rear truck	17,250 lbs.
Weight, total engine	425,900 lbs.

EDUCATIONAL WASTE.—Of thirteen millions of young men in the United States between the ages of 21 and 35, only five per cent. receive in the schools any direct preparation for their vocations; and of every one hundred graduates of our elementary schools, only eight obtain their livelihood by means of the professions and commercial pursuits, while the remaining ninety-two support themselves and their families by their hands. If we are open to conviction, we need no investigation to convince us that the public school system of this country has not been developed and maintained for the benefit of the masses, but rather has been operating for the benefit of the few. We have no possible right to build up a general scheme of public primary and secondary education with the college as the goal. This is sacrificing the many for the benefit of the few; a useless sacrifice because the few can be taken care of without resorting to such wasteful methods.—*Dr. Alexander C. Humphreys before the National Society for the Promotion of Industrial Education.*

PENSION REGULATIONS ON THE "NORTHWESTERN."—The directors of the Chicago & Northwestern have amended the pension regulations of the company so that hereafter the smallest pension will be $12 a month. This will increase the pensions of about 125 of those now on the list. At one per cent. for each year of service twelve dollars would be the pension for an employee who had worked at $36 a month and had been in the service 33 years, 4 months. By the new regulation such a man will receive the $12 even when his term of service has been much shorter.



"NEW MODEL" 42-INCH BORING AND TURNING MILL WITH TURRET HEAD.

BORING AND TURNING MILLS.

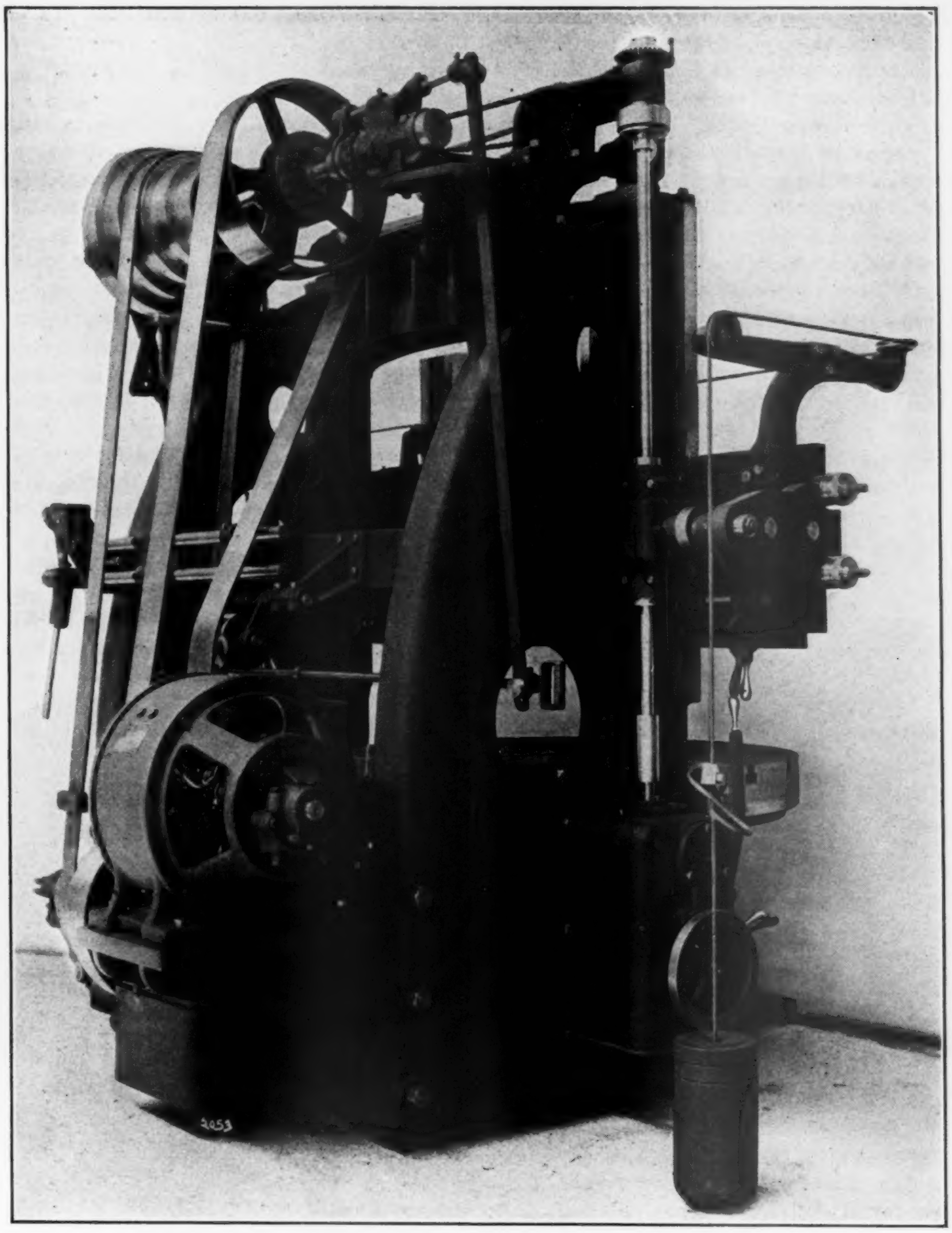
A new line of vertical boring and turning mills, including five sizes—42, 48, 54, 60, and 72 inch swing—has just been brought out by the Colburn Machine Tool Company, of Franklin, Pa. With the exception of the method of driving the table, the same features are incorporated in all the sizes and a description of any one size practically covers all the others. All sizes are built with two swivel heads, and the three smallest sizes with turret heads as desired.

The table spindle has a massive angular thrust bearing which makes it self-centering, and, together with the large straight upright bearings, effectually resists vertical, angular and horizontal strains. All bearing surfaces of the spindle are lubricated from a one-sight feed oil cup. The proper height of the oil is always shown by a mark on the glass. A constant flow of oil is maintained on the large conical bearing. The table is driven by a spur gear of large diameter attached directly to it. No lifting tendency is possible with this type of drive. An external spur gear is used on the 42, 48 and 54 inch mills, and an internal gear on the 60 and 72 inch.

Power is transmitted through the five-step cone pulleys of large dimensions, thence through the speed box containing the back gears and positive clutches which are constantly immersed in a bath of oil. The back gears are engaged and disengaged by means of positive clutches inside of the speed box and operated by a lever conveniently located at the side of the machine. Five speeds are obtained with the back gears out, and five more with the back gears in, making ten speeds in all in geometrical progression. The speed box when assembled is perfectly oil tight and the proper height of oil is shown by the sight feed oil cup on the outside. All the bearings have phosphor bronze bushings, and ring oilers for additional protection against heating. Should it be necessary at any time to make repairs, the speed box may be quickly removed from the machine and every part is then easily accessible.

A belt shifter is furnished on these mills, which is simple, effective and easily operated. By means of this shifter, operated entirely with one hand, the belt may be changed from one step of the cone pulley to another with wonderful rapidity and without injury to the belt. In actual operation the entire range of speeds obtained with the cone pulleys, from the slowest to the fastest and back again, stopping momentarily on each step, has been made in eight seconds. By changing the back gear lever, which is in close proximity to the handle that operates the belt shifter, another run of five additional speeds may be obtained. A speed index plate located on the housing directly above the back gear lever indicates the right step on the cone pulley and the position of the clutches inside of the speed box for any given speed of the table.

The countershaft is attached directly to the upper part of the housings by means of brackets having ring oiling bearings, and thus becomes a part of the machine itself. The belt from the line shaft can be shifted, thus starting or stopping the machine from either side of the mill by means of the horizontal rod having a spade handle at each end. To enable the operator to stop the machine with the table in any desired position, a friction brake is furnished which is operated by a foot treadle placed within easy reach at the operating side of the machine. The brake is applied to the inside of the lower driving cone pulley by means of a taper friction with hard maple shoes or wedges. In actual operation the mill can be stopped and started, all the table



REAR VIEW OF "NEW MODEL" MOTOR DRIVEN BORING AND TURNING MILL.

speeds changed, back gears thrown in and out and the foot brake applied without the operator leaving his position at the side of the machine.

The crossrail is of the box type with deep arched back and is of extra large proportions. It is raised and lowered by power. The swivels are of large diameter with broad bearing surfaces, and the metal over the T-slots is extra heavy to withstand the strain of five large clamping bolts. Angular adjustments are made by worm and gear, which also act as a positive locking device, making it impossible for the heads to accidentally fall over sideways when the clamping bolts are released. The rams are massive and have steel racks inset into their sides. Cored openings extend clear to the top so that extra long boring bars may be used.

The feed mechanism for each head is contained in a separate case, one on each side of the mill. By turning the handwheel one revolution five changes of feed are obtained. A movement of the multiplying lever changes the combination of gears, and another revolution of the handwheel gives five more changes, making ten in all. The vertical feed shaft extending upward from each feed case engages with a mechanism on each end of the rail that conveys motion to the horizontal rods and screws in the crossrail, which operate the heads vertically and horizontally. The usual slip gears on the ends of the rods and screws are eliminated, and quick adjusting positive clutches are substituted which enable the operator to instantly change the feed from vertical to horizontal and vice versa. Either feed may be reversed instantly by the feed reverse lever shown at each end of rail.

Rapid traverse of the tools, horizontally, vertically and in angular directions is obtained from the same vertical shafts as the feed, the manipulation being by a vertical lever attached to the front of the feed case. This lever has two operating positions: Forward and backward. The gear feed is always engaged when the lever is in the back position and the tool will feed in the direction determined by the position of the feed reverse lever at the end of the crossrail. The rapid traverse is always engaged when the lever is in the forward position, and the tool will travel rapidly in the opposite direction from the gear feed. It is impossible for the operator to throw the rapid traverse in the wrong way, and there is no chance for an accident to occur.

It makes no difference whether the tool is feeding to the right or left, horizontally, or up or down vertically, the same lever controls the feed and rapid traverse in every case, and pulling the lever always throws the gear feed out and the rapid traverse in, thus reversing the direction of the travel of the tool. This arrangement of gear feed and rapid traverse simplifies the whole process of rapid manipulation of the tools, and makes a safety device that is not only theoretically but is practically fool proof.

Although the rapid traverse is an indispensable feature, en-

abling the operator to quickly move the tools in any direction, it does not allow a fine adjustment to be made. To accomplish this it has usually been necessary to go to the end of the crossrail and make the final adjustment by means of a crank handle. This is unnecessary on the "New Model" mills. Both feed screws and rods in the crossrail are splined and each has a capstan collar fitted thereto with keys which fit the spline so that by turning the capstan collars with a small lever furnished for this purpose, the rods and screws are turned also. With this device the operator can stand close to his work and by placing the capstan collars in the most convenient place, make the finest adjustments of the tools in any direction without leaving his position. When the heads are moved out on the end of the crossrail these collars slide back behind the heads, and it is not necessary to make the rails longer on account of them.

A safety shear pin device placed on the rear of each end of the crossrail prevents injury to the feed mechanism in case the heads are accidentally run together or from other causes. Any abnormal strain on the feeding mechanism in excess of that necessary to take the heaviest cuts will shear this pin off and thus protect the gears and mechanism from breakage. The whole operation of taking out the old pin and putting in a new one only takes a few seconds. There is nothing to adjust or to get out of order about the device.

When cutting threads the feed change handwheel is set so that the vertical feed shaft and the table revolve in unison. A single tooth clutch on the lower end of this shaft insures the threading tool always catching the thread in taking successive cuts, and the rapid traverse device is used to return the tool quickly to its starting point.

The thread cutting attachment is not furnished regularly, but can be put on at any time.

A constant speed motor is recommended for these mills, since the mechanical belt shifter and clutches in the speed box give all the changes of speeds desired. The motor is mounted on a bracket at the rear and belted to the pulley on the countershaft. In order to enable the operator to stop and start the mill without stopping the motor a clutch pulley replaces the regular tight and loose pulleys, and is operated by the same levers with handles on both sides of the mill.

TUNGSTEN LAMPS IN A WRECK.

The collision between a Pennsylvania eastbound passenger train and an engine, just outside Jersey City on the morning of November 8th, resulted in comparatively few injuries to the passengers, due to the fact that the strong frames of the passenger cars resisted crushing. One of the steel passenger coaches jumped the track and turned over on its side, denting in the steel plates about 18 inches.

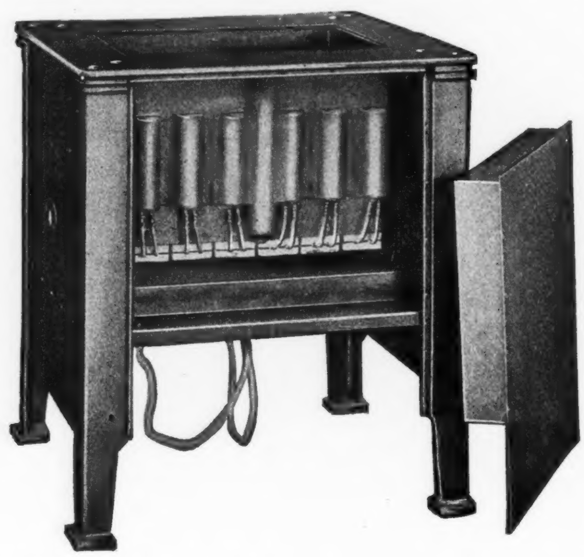
In the lighting equipment of this car were nine General Electric tungsten lamps. After the wreck, when all the lamps were taken out and tested, the tungstens were found to be in perfect condition—a further proof of the rather remarkable strength and durability of the tungsten filament when specially adapted for train lighting service.

Pennsylvania Stockholders.—The average holding of Pennsylvania Railroad stockholders is 115 shares, the par value of which is $5,750. Of the total 55,270 stockholders, 26,904, or 48.62 per cent., are women. There are 16,812 stockholders living in Pennsylvania, the average individual holdings amounting to $4,800 stock. In New York there are 8,648 stockholders, and their average holdings are $11,800 stock. More than 12,000 holders live in New England, while 8,530 are scattered throughout the country. About 18 per cent. of the entire capital stock of the company is held abroad. On November 5 there were 8,726 stockholders in foreign countries, and their average holdings were $6,550 stock. The total number of stockholders of the Pennsylvania has increased by 9,841, or 21.6 per cent., in the past two years.

ELECTRICALLY HEATED OIL TEMPERING BATHS.*

H. Fulwider.

There are several ways of drawing temper, but it is usually accomplished by one of the two following methods: In one, a skilled workman judges the proper tempering temperature by degrees or shades of color; in the other, a thermometer of precision registers the temperature and the workman simply follows a chart—a physiological process against a physical one. In the former method, the steel is introduced into a furnace having a temperature between 500 degrees and 600 degrees F.; in the latter it is immersed in a liquid bath, the temperature of which is between 400 degrees and 550 degrees F. In the first case, good quality of product requires that the workman be experienced, and capable of accurately judging the degree of temper in the metal by the color shown. This means that the operator must be well paid, resulting in a consequent increase in cost of production. With the latter method, it is only necessary to have a table of temperatures corresponding to certain degrees of hardness in the steel. The operator can then place the work in the bath, bring the latter to the required temperature, indicated by a thermometer, and hold it at that temperature as long as necessary. By this last method tools will be produced having a uniform degree of hardness, independent of what workman does the work. In addition to this, one man can temper a greater quantity of tools in a given time than with the air blast furnace of the first method.



ELECTRICALLY HEATED OIL TEMPERING BATH, SHOWING HEATING UNITS.

Formerly the oil tempering bath was heated either by means of gas or fuel oil. These sources of heat, although satisfactory to a certain extent, are objectionable because of the fire risk resulting from an open flame, and the difficulties of obtaining close temperature regulation. Realizing these facts, the General Electric Company has developed a line of electrically heated oil tempering baths which overcome these objections. These baths can be located at any desired point in the factory with perfect safety. The temperature of the bath is easily controlled by means of regulating switches which vary the amount of energy consumed.

The general appearance of the electrically heated bath is shown in the illustration. The bath proper consists of a rectangular cast iron tank having six lugs cast vertically on each side, and evenly spaced; these lugs being drilled out so that "cartridge" type heating units can be inserted in them. It is found that by thus distributing the units, an even temperature can be maintained in all parts of the oil.

* From the November, 1909, number of the *General Electric Review*.

The bath is surrounded by a heat retaining jacket made up of one bottom and four side sections. These sections are built up in the form of sheet metal boxes with an internal space of three inches, which is filled in with mineral wool. The jacketing on both sides of the tank where the units are located is easily removable. This construction allows of quick access to the internal connections of the units.

A wide flange is provided at the top of the tank, and to this are secured four cast iron legs of suitable length. A drain pipe controlled by a globe valve provides a means of drawing off the oil. At one end of the tank there is a protected recess, in which is placed the thermometer that indicates the temperaure of the oil. It is through the agency of this thermometer that the proper degree of hardness can be given to the tools which are being tempered, independent of the judgment or skill of the operator.

When desired, a cast iron basket or tray can be supplied, in which are placed the tools to be tempered. The bottom of the basket is perforated with seven-eighth inch holes which permit the oil to circulate and drain freely. There are feet on the bottom of the basket which keep the work at a distance of one inch or more above the bottom of the bath.

The following table gives inside dimensions, weight, oil capacity and energy consumption of the three standard sizes.

No.	Length	Width	Depth	Weight	Oil	Kilowatt
1	22″	12″	8″	420 lbs.	9 gal.	6
2	18″	12″	12″	475 lbs.	11 gal.	7.2
3	30″	16″	18″	900 lbs.	37 gal.	20

NOTE.—All sizes furnished for either single or multiple heat control.

The maximum energy consumption of these baths is sufficient to heat the oil to a temperature of 450 degrees F., in less than one hour, starting cold. The maximum temperature which it is possible to obtain is about 600 degrees F.; which is very close to the flashing point of the oil commonly used for tempering purposes. The following is a list of tools, with the temperatures to which they should be raised in drawing the temper:

430 Degrees F.

Scrapers for brass.	Ivory cutting tools.
Steel engraving tools.	Planer tools for iron.
Slight turning tools.	Paper cutters.
Hammer faces.	Wood engraving tools.
Planer tools for steel.	Bone cutting tools.

460 Degrees F.

Milling cutters.	Chasers.
Wire drawing dies.	Punches and dies.
Boring cutters.	Penknives.
Leather cutting dies.	Reamers.
Screw cutting dies.	Half round bits.
Inserted saw teeth.	Planing and molding cutters.
Taps.	Stone cutting tools.
Rock drills.	

500 Degrees F.

Gouges.	Wood boring cutters.
Hand plane irons.	Drifts.
Twist drills.	Coopers' tools.
Flat drills for brass.	Edging cutters.

530 Degrees F.

Augers.	Cold chisels for steel.
Dental and surgical instruments.	Axes.

550 Degrees F.

Gimlets.	Cold chisels for wrought iron.
Cold chisels for cast iron.	Molding and planing cutters to be filled.
Saws for bone and ivory.	Circular saws for metal.
Needles.	Screwdrivers.
Firmer chisels.	Springs.
Hack saws.	Saws for wood.
Framing chisels.	

In shop practice there seems to be a difference of opinion in the matter of drawing the temper of tool steel, the point of contention being whether the steel should be gradually raised to the tempering point, or whether it should be plunged into a bath which is already at the tempering temperature.

The difference gives rise to two methods of oil tempering. The first is to bring the bath to a temperature of about 250 degrees F., then place the work in the bath, and turn on full heat until the oil reaches the desired temperature, when the current is turned off and the work removed. If this procedure is followed, the steel, being introduced at a comparatively low temperature and then gradually heated to the proper point, is not subjected to any shock, and there is therefore no danger of injuring the quality of the tools.

The second method is to maintain the oil bath at the required temperature and plunge the steel into the oil, allowing it to remain there just long enough to acquire the same temperature evenly throughout the metal. The tools are then removed and a new lot is submerged.

By this latter method the process of tempering can be carried on without interruption, whereas in the first method it is necessary each time to cool the bath down to a temperature of about 250 degrees F. before introducing a new lot of steel, with a consequent decrease in output. Thus both methods have their advantages; but the one of gradual heating up involves no doubt as to the quality of the tool.

TECHNICAL PUBLICITY ASSOCIATION.

The Technical Publicity Association held its December meeting on Thursday, the 9th. After the usual informal dinner a lively discussion ensued over the subject of circulation and the introduction of the proposed uniform advertising contract for trade papers. The attendance was large, and the participation in the discussion of prominent technical advertising men and trade paper publishers, who were present, made the session a most profitable one.

William H. Taylor, treasurer and manager of the *Iron Age*, opened the discussion, giving it as his opinion that the true measure of a publication is its editorial quality. He said there was no more discriminating class of people in existence than subscribers to a publication. Advertisers should put themselves in the proper frame of mind in approaching the circulation question. He granted their perfect right to know how many and who read a publication, and he said no good publication refuses such information. The trouble has been, not that the publishers have been ashamed of their circulation, but that wrong deductions may be made when a reputable publisher's statement is placed in comparison with an untruthful one.

H. L. Aldrich, publisher of *International Marine Engineering* and the *Boiler Maker*, exampled his papers as an instance of necessarily small circulation with intensified buying power in which quality was by far the greater consideration.

C. S. Redfield, advertising manager of the Yale & Towne Mfg. Co., and president of the T. P. A., explained how members considered the circulation statements of publishers, being in some cases absolute sworn statements, also the possibility of detecting the liars.

John McGhie, of the *American Machinist*, told about the passing of old-time advertising solicitation in which the hypnotic eye played a prominent part, and said that after trying all other policies, publishers have learned that the truthful policy is the best. The advertiser buys reputation and editorial force quite as much as circulation.

O. C. Harn, advertising manager of the National Lead Company, said that every good advertising man was perfectly aware of the value of quality in circulation, but said that, nevertheless, it came down to quantity after all, but based on judgment of that quantity from a quality standpoint.

H. H. Sweatland, publisher of *Automobile*, said it was his purpose as a publisher to furnish maximum quantity, but that for a class paper to go beyond a certain quantity was simply to vitiate itself. A phenomenal solicitor, he said, once got a thousand subscriptions within a radius of twenty miles, but after two years only one more subscriber was on the list for that district than there was prior to his solicitation.

A HEAVY FREIGHT TRAIN.—A trainload of coal drawn over the Virginian Railway recently, consisting of 120 steel coal cars, with an engine and caboose, is said to have been 5,286 ft. long, or 6 ft. more than a mile. The weight of the coal in the train is given as about 6,000 tons.

GOOD RESULTS FROM THE USE OF A GRAPHIC RECORDING METER.

An example of the value of the graphic recording meter * for analyzing power loads was recently shown in a sub-station that supplies power to the terminal yards of a large railroad system. In this instance, as a result of the application of the meter, it was found possible to reduce the capacity of the machines operating by more than half, thereby diminishing operating expenses and improving the efficiency and load factor of the remaining generating equipment.

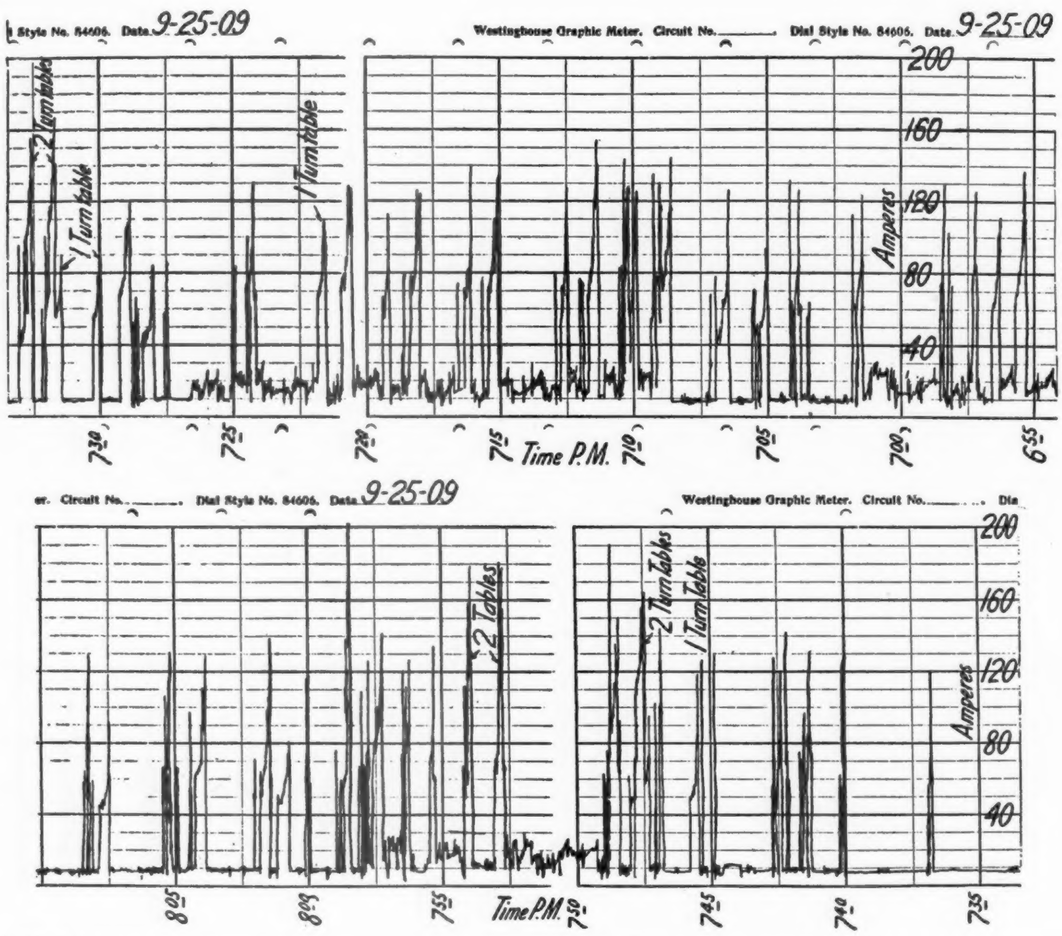
The sub-station referred to contains one 37½ k.w. and two 25 k.w. motor generator sets. These supply direct current at 250 volts to three turntables and one small crane. Each of the turntables is driven by a 22 h.p. series motor with rheostat controller, and is capable of turning a locomotive 180 degrees, or end for end, in one minute. The crane is about five tons capacity and subject to very intermittent service, so that its operation has little effect on the total station load.

The turntables are held ready for service at all times. Rush hour periods occur in the morning and evening, and at these times the tables are usually very busy. A locomotive to be turned goes to the nearest unoccupied table, and in this way it is rarely the case that two turntables are started at once, although two or three may be in operation at the same time.

Before the study of the actual load conditions had been begun, it was customary to operate all three motor generator sets during the rush hours. At these times the violent oscillation of the needles of the indicating meters on the generating panels, striking against the stops, seemed to indicate that more generating capacity was needed. In order to determine this latter question definitely, a Westinghouse graphic recording meter was obtained and inserted in the main feeder. The tests covered a week's careful study, during which time the load on the station was continuously recorded. That section of the curve reproduced herewith was secured during one of the rush periods. To obtain a clear record, a paper speed of 24 inches per hour was used.

The record shows that the average peak encountered during the starting of a turntable is 120 amperes. This drops to a value of from 50 to 70 amperes during operation, after the table has been accelerated. The maximum peak noted was about 180 amperes at the time of starting two turntables simultaneously. As the full load current of the 37½ k.w. motor generator set alone is 150 amperes, it becomes very clear that the existing station capacity is ample to handle the present service besides a large future increase.

Since the tests it has been found necessary to operate only the one largest unit, and the former practice of running all three sets has accordingly been discontinued. The result has been improved operating economy, efficiency and load factor. In spite of a suspected insufficient station capacity, it was demonstrated that less than half the equipment already installed was needed for the existing demand.



GRAPHIC RECORDING METER RECORD OF POWER REQUIRED FOR OPERATING THREE TURNTABLES AND A SMALL CRANE.

* Described in the August, 1909, issue of this journal, page 323.

THE AIR BRAKE MAGAZINE.

The first number of a new monthly magazine, known as *The Air Brake Magazine,* published at Meadville, Pa., was issued about the first of December. It is 7 by 10 inches in size and has 66 pages of editorial matter, including several illustrated articles. The editorial department is under the management of Frank H. Dukesmith, well known as an air brake expert and as the author of "Modern Air Brake Practice, Its Use and Abuse." He will have as associate editors W. H. Foster, a master mechanic of the New York Central Railroad, and formerly general air brake supervisor of that system; J. C. Hassett, technical instructor of apprentices of the Erie Railroad; T. W. Dow, general air brake supervisor of the Erie Railroad; and H. F. Mentzel, S. M. P. of the Allegheny Valley Street Ry. Co.

A VANADIUM BRONZE FOR RAILROAD SERVICE.

Vanadium, the master alloy, has enabled the manufacturer and the foundryman, by reason of its incorporation in iron and steel, to produce locomotive frames, cylinders, springs, tires and wheels with double the strength, elasticity and wearing qualities heretofore attained. The same distinctive advantages are found in a composition called Victor vanadium bronze, which is a secret alloy containing vanadium, embracing qualities of strength, lightness and forging powers said to be possessed by no other brass or bronze on the market.

The most important properties claimed for it are: It is a very clean and uniform metal, with the strength of high priced alloy steels, as demonstrated by the tables herewith presented. It has a very close structure and wonderful ductility, as evidenced by the illustration showing the twisted lever. Its wearing qualities are 50% superior to the bearing metals in general use on the railroads. It is lighter in actual weight than any other bronze casting of the same dimensions. It is the only bronze that can be forged satisfactorily.

Vanadium is unexcelled as a cleanser and scavenger. It removes all the poisonous gases and impurities and has the peculiar property of practically eliminating the danger of crystallization. Uniformity of metal is assured and a closeness of structure is attained that not only toughens the molecular structure, but also eliminates the porous features so often encountered in brass and bronze.

The wearing qualities of this metal are shown in a comparative test with a regular bearing metal that is practically the same as that used by the majority of railroads for locomotive bearings, and also with a high grade bearing metal. Great weight is always an undesirable feature and is the first thing sacrificed if the strength is not impaired. Victor vanadium bronze has been practically standardized in the submarine vessels of the United States Navy, where bronze must be used in many places instead of iron or steel, on account of its anti-corrosive properties, not only because of its superior strength and ductility, but also because it is so much lighter in weight than any other bronze casting.

COMPARATIVE BEARING TESTS OF VICTOR VANADIUM BRONZE AND OTHER COMPOSITION METALS.

Bearing Number	R. P. M.	Load In Lbs.	Time Min.	Time Sec.	
1	400	3000	2	15	Victor vanadium bronze
2	400	2000	1	30	Victor vanadium bronze
3	400	2000	1	45	Victor vanadium bronze
4	400	2000	1	00	Regular bearing metal
5	400	2000	1	15	High grade bearing metal
1	400	3000	2	15	Victor vanadium bronze
2	400	2000	1	30	Victor vanadium bronze
3	400	2000	1	45	Victor vanadium bronze
4	400	2000	1	00	Regular bearing metal
5	400	2000	1	15	High grade bearing metal

Composition No. 1. Type "C" Special Victor vanadium bronze.
" No. 2. Type "B" Superior Victor vanadium bronze.
" No. 3. Type "A" Regular Victor vanadium bronze.
" No. 4. Regular bearing metal—81% copper, 9% tin, 6% lead, 4% spelter, trace of phosphorus.
" No. 5. High grade bearing metal, 84% copper, 12% tin, 4% lead, trace of phosphorus.

Each of the samples of metals were placed on the machine twice. It will be noted that the time of run checked up exactly in each case. The bearings were placed on a shaft 2 15/16 in. diameter, and the bearing surface in each case was 9 square inches. The speed throughout the test was the same, 400 revolutions per minute. 50% more load was applied to special Victor vanadium bronze composition and its time of run was much greater than the other metals. The load applied amounted to 333.33 lbs. per square inch in special Victor vanadium bronze bearing and 222.22 lbs. per square inch in all the other bearings.

Forging bronze castings has been considered a lost art, but this metal will forge very readily, as shown by the twisted lever in the illustration.

TWISTED LEVER SHOWING FORGING POSSIBILITIES OF VANADIUM BRONZE.

One of the most expensive items in railroad repair work is bearing brass, and any feature tending to diminish this expense is of decided interest to every railroad. No parts are subjected to more wear and tear and are more essential to the safety and economy of railroad transportation than the bearings of locomotives and cars. Innumerable compositions have been tried and many patented forms and devices have been tested, until the railroads, with very few exceptions, have adopted the general formula of 80% copper, 10% tin, and 10% lead for bearings. This composition has by no means eliminated hot boxes, melted bearings, or many other troubles too numerous to mention, but has remained in general use for some time for lack of something better.

Victor vanadium bronze, by reason of its ductility and wearing qualities, as shown by the table of tests, its toughness and strength, and its lighter weight, make it an ideal metal for bearings of all descriptions. By its use repair costs and loss incidental to time out of service when in the repair shop, are cut in half and hot box troubles will be reduced to a minimum.

Injectors and valves must use brass or bronze and great difficulty has been experienced in getting a metal that is not only non-corrosive, but with a sufficiently close molecular structure and strength to withstand the pressures. Victor vanadium bronze has been subjected to a pressure of 9,000 pounds in a cylinder only nine-sixteeenths inch thick, three inches in diameter, and fifteen inches long.

This metal has also been used with great success in locomotive bells. The principal requirements for this service is a metal that will give a pure, full ringing sound, which is, however, only obtained with an alloy showing in addition to great homogeneousness and hardness a considerable degree of strength. Tin is used to a great extent to obtain this condition, and while hardness and clearness of tone are attained it reduces the metal to such a state of brittleness that fractures are very likely to occur. As Victor vanadium bronze is a pure, uniform metal of close structure, with a strength equal to that of high priced alloy steels, it makes an ideal metal for bells.

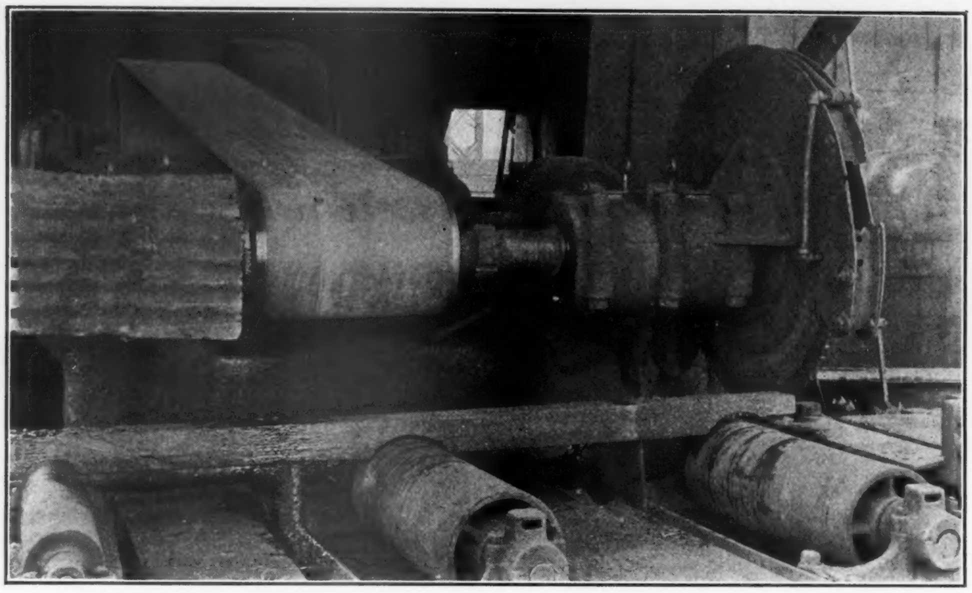
The physical properties shown in the test tables herewith presented prove the economic necessity of such a metal in all movable and frictional parts where corrosion is liable to occur and in bearings, valves, injectors, rods, tubes and other parts liable to unusual shocks, strains, stresses and vibrations.

VICTOR VANADIUM BRONZE.

	Ultimate Strength	Elastic Limit	Elongation 2 inches	Reduction of Area
Plate-Hot Rolled	72,300	34,050	29%	22.8%
Plate-Cold Rolled	95,270	74.510	10%	12.2%
Rod-Hot Rolled, ⅝″ to ½″	96,000	83,900	7%	12.6%
Rod-Cold Rolled, ¾″ to ⅝″	92,090	80,070	11.5%	29.3%
Wire ⅜″	101,000	83,180	10%	31.8%
Castings	71,000	28,500	32%	27.8%

Victor bronze was formerly owned and manufactured by the Victor Metals Company of Massachusetts, and their business was practically confined to marine work; the Vanadium Metals Company of Pittsburgh, Pa., who have purchased the process, etc., have inaugurated an aggressive campaign for railroad work, and expect to make the latter their special field.

Emery wheels run wet are usually operated at a speed of 4,000 ft. per minute, which is about as fast as they can run and keep the water on the surface of the wheel.



A BELT DRIVING A FRICTION SAW AND OPERATING SUCCESSFULLY IN EXCEPTIONALLY SEVERE SERVICE.

REMARKABLE BELT PERFORMANCE

One of the most interesting examples of belt transmission to be found in this country is at the Passaic Steel Company, Paterson, N. J. Under a barn-like shed at one side of the plant is a great friction saw that has teeth 2½ inches apart; the teeth are no more than slight indentations. This saw runs at such a high speed that it will cut in two a Bessemer steel rail in just eleven seconds. It is also used to cut 20-inch I-beams.

It was a most difficult problem to find a belt that would not only transmit more than 200 horsepower, but which would hold up when going at a rate of more than a mile and a half per minute. The saw is operated by a 250 horsepower motor. The driving pulley of the motor is 44 inches in diameter, and the driven pulley is 14 inches in diameter. To operate the saw at sufficient speed it is necessary for the driven pulley to operate at a rate of 2,800 revolutions per minute. This means that the belt must travel 9,324 feet per minute.

Three months ago a Victor-Balata belt was installed. It was put on at first installation with Jackson fasteners. When operating at this high rate of speed the roar of the Jackson fasteners coming in contact with the air and pounding on the small pulley could be heard for blocks. It was decided to take off the Jackson fastener on this account and the 24-inch, 6-ply belt was fastened by means of a hinged rawhide lace joint. Since that time the belt has been working smoothly and evenly. One of the difficulties in connection with this service is that the belt is required to pull the entire load the instant the saw touches the rail. The driven pulley is entirely out of doors. The freezing and moisture and the fine steel chippings getting on the pulley side of the belt have not affected it.

POSITIONS OPEN IN GOVERNMENT SERVICE.

The United States Civil Service Commission announces an examination on January 12, 1910, to secure eligibles from which to make certification to fill vacancies as they may occur in the position of engineer-physicist at $3,000 per annum or associate engineer-physicist at $2,000 to $2,500 per annum, in the Bureau of Standards. It is desired to secure persons who are fully able to initiate and carry on independent research in the field of engineering physics. They should have training and experience in the inspection and testing of engineering and structural materials, the operation of testing machines, and the interpretation of the results of investigations. There will be no educational examination for these positions, but it is essential that applicants should have made and published some contributions of recognized merit in engineering knowledge. Applicants should submit the titles of all papers they may have published and give references to the original source of publication. Applicants will be rated according to their training, experience, and original investigations. Applicants must furnish on the application form the vouchers of two persons who are able to testify from their personal acquaintance in reference to the fitness of the applicant for the position sought. It is desirable that the vouchers should be persons belonging to the same profession, or pursuing the same line of work as the applicant. Age limit, 25 years or over on the date of examination.

The Commission also announces an examination on January 19, 1910, to secure eligibles from which to make certification to fill two vacancies in the position of engineer in wood preservation, one at $1,000 and the other at $1,300 per annum, Forest Service, for duty in District No. 2, with headquarters at Denver, Colorado, and vacancies requiring similar qualifications as they may occur, unless it shall be decided in the interests of the service to fill either or both of the vacancies by reinstatement, transfer, or promotion.

Applicants for the above positions should apply at once to the United States Civil Service Commission, Washington, D. C.

HIGH PRESSURE PINTSCH GAS FOR TRANSPORT SERVICE.

Recent experimental research made by the Pintsch Compressing Co. has developed the fact that dry Pintsch gas such as is obtained by the regular Pintsch process is suitable for transportation under a pressure of 100 atmospheres or over. For this purpose Pintsch gas, from which all liquid hydrocarbons have been removed while under the pressure of 14 atmospheres, is used, and the dry gas is compressed directly into steel flasks at high pressure. Under this high pressure a partial condensation of the gas takes place, which, however, disappears as soon as the pressure is reduced, the gas presenting again its original dryness and other characteristics with but an inappreciable loss in candle power.

A steel flask of 3.75 cubic feet capacity and weighing about 330 pounds, will, when charged to a pressure of 100 atmospheres, yield about 500 cubic feet of gas at atmospheric pressure. From this it is seen that the gas under these high pressures deviates considerably from Boyle's Law, in accordance with which the flask would be expected to yield but 375 cubic feet of gas at atmospheric pressure. The deviation from Boyle's Law at a pressure of 100 atmospheres amounts to about 33%, the flask containing a correspondingly larger quantity of gas. This departure, combined with the fact that small seamless flasks can be constructed of an extremely high tensile strength steel, render

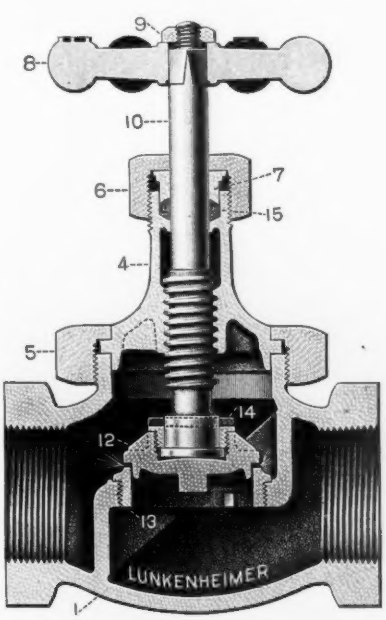
it possible to reduce the weight of the transport holder for a given quantity of gas carried by over 50% of that of the former weight of transport holders used. The space or volume occupied by the high pressure holders is, at the same time, nearly ten times less than that of the holders used in transporting gas at a pressure of 14 atmospheres.

The true value of the high pressure transportation becomes most apparent in cases where no compressing facilities are available at the point of distribution to transfer the gas from the transport holder to buoys or cars; or where, in other words, filling can only be accomplished by equalizing the pressure. In such cases, but about 30% of the gas carried in transport holders at a pressure of 14 atmospheres is available for filling, and the remainder of the gas returns to the supply station unused. In the case of high pressure transportation, however, fully 90% of the gas transported becomes available for filling, and under these circumstances the reduction in weight of the transport holders for a given quantity of gas filled to buoys or cars, is about six times less, and the volume about thirty times less than that of the transport holders used by the former method.

There exists a distinct difference between high pressure Pintsch gas and the so-called Blau gas. The former is a dry gas, possessing all the well-known characteristics of regular Pintsch gas, great care being taken in the process of manufacture to remove from the gas all liquid hydrocarbons. The same liquid hydrocarbons are retained in the Blau gas, and others added, to exert a solving influence upon the remaining dry constituents of the gas, and thus effect a reduction in volume. The presence of the hydrocarbon liquids is the direct cause of difficulties experienced in connection with Blau gas, due to accumulation of liquid in the regulating devices at the point of consumption, and due to freezing up in cold weather.

AN IMPROVED VALVE.

Because of its durability and efficiency, the valve shown in the illustration has been adopted by a number of railroads. It is made of a bronze composition containing a high percentage of copper and tin and will readily withstand long and severe usage. The most important feature in the design is the construction of the seat and the disc. The disc, 12, is provided with a projecting



"RENEWO" VALVE.

ring that enters the valve seat ring, 13. Its principal function is the preservation of the seat, which is accomplished in a twofold manner: First, as it enters the seat, it deflects the current of steam from the seat ring face, thus preventing the wire drawing that would otherwise occur; this feature is especially important should the valve be left partially open for any length of time. Second, the seating surface is kept free from scale and grit by the action of the thin current of steam discharged over it as the disc is brought home.

Another function of this extension ring is the prevention of water-hammer, caused by the sudden admission of steam, for it will readily be seen that no matter how quickly the handwheel may be operated, the flange will only permit the steam to enter gradually.

The seat, 13, is made of nickel and is removable; it may be removed from the valve body by using a flat bar to engage the lugs on the inside of the ring. Attention is directed to the fact that the seat may be reground a number of times before it is necessary to renew it. Not only is the seat renewable, but all of the other wearing parts, including the disc, can be renewed if necessary. The hub is securely held to the body by means of a union ring, making it impossible for the hub and body to become corroded together, as the thread which holds the union ring to the body is protected at all times from the action of the steam, the joint being made between the flange on the hub and the neck of the body. This connection also acts as a tie or binder in screwing over the body, and tends to strengthen the valve. The stuffing-box can be repacked under pressure when the valve is wide open, as a shoulder on the stem, directly above the threads, forms a seat beneath the stuffing-box.

The valve is guaranteed for working pressures up to 200 pounds, and is made in globe, angle and cross patterns with screw or flange ends. It is used on the Union Pacific Railroad in connection with the ash pan equipment. This type of valve is known by the trade name of Renewo, and is manufactured by the Lunkenheimer Company of Cincinnati, Ohio.

PENSIONS ON THE NEW YORK CENTRAL.

All employees are to be retired at the age of 70, even though they may not have served the necessary term of ten years to entitle them to a pension. If twenty years in service and unfit for duty an employee may be retired with a pension, although he has not reached the age of 70. Employees who wish to be retired before the age of 70, will have to submit to examination by a physician. In computing the length of time that an employee has been in the service, his service on any of the roads owned, leased or operated by the New York Central will be counted, provided, in the case of a transfer from one company to another, the transfer was not because of dismissal or suspension, and was approved by the employing officers of both lines. A temporary lay-off, of not over one year, on account of reduction of force, and suspensions for discipline, will not be treated as causing a break in the continuity of service.

The rates will be similar to those of the Pennsylvania, 1 per cent. of salary for each year of continuous service, based on the average salary for the last 10 years. The Pension Board will consist of J. Carstensen, A. H. Smith, C. D. Schaff and A. H. Harris, vice-presidents; R. H. L'Hommedieu, general manager (Michigan Central); J. F. Deems, general superintendent of motive power; D. C. Moon, general manager (Lake Shore), and J. Q. Van Winkle, general manager (C., C., C. & St. L.). The New York Central has appropriated $225,000 for the first year; the Lake Shore & Michigan Southern, $85,000; the Cleveland, Cincinnati, Chicago & St. Louis, $70,000, and the Michigan Central, $56,000. The usual proviso is inserted in the rules that, if necessary to keep within the limit of the appropriation in any year, the directors may reduce the rate of the pensions.

INDUSTRIAL EFFICIENCY.—The problem of the industrial efficiency of the coming generation is inextricably interwoven with the problems of public playgrounds and gymnasiums, of the sanitation of houses, of the congestion of tenements, and of the hours of labor of women and children.—*Dr. George H. Martin before the Nat. Soc. for the Promotion of Industrial Education.*

ELECTRIC DRILLS AND GRINDERS.

In the June, 1909, issue of this journal the Coates flexible shaft was described in connection with several applications of special interest to the railroads. The use of a flexible shaft of this type, having a high degree of efficiency in transmitting power, has made it possible to use to advantage portable electric motors for drilling and grinding operations throughout erecting shops and engine houses.

Fig. 1 shows a breast drill driven through a 6 ft. No. 31 Coates unit link flexible shaft by a ¼ h. p. motor. The motor may be placed on the floor out of the way, leaving the free use of both hands for handling the breast drill and the light flexible shaft. The drill may be instantly started or stopped by giving the sleeve a quarter turn. The twist drill may be removed and be replaced by a clamp spindle that takes emery wheels or buffers. The breast drill in the illustration is designed for drilling in steel up to ½ in. It has a 6½ to 1 worm feed reduction. The flexible shaft thus operates at six and one-half times the speed of the drill, adding to its efficiency.

The larger size breast drill (Fig. 2), having a variable speed, may be used in place of the one shown in Fig. 1. This drill has three changes of speed, obtained by moving the changing button, and giving speed reductions of 4.8 to 1, 7.5 to 1 and 12 to 1. The chuck has a ½ in. capacity but is strong enough to drill a ¾ in. hole. It is equipped with ball bearing thrusts. The speed variation is obtained by gearing in the drill, the flexible shaft and motor operating at a constant high speed and thus at maximum efficiency at all times.

An application of a drilling outfit including a one horse power electric motor, mounted on a truck, eight feet of flexible shaft, a variable speed drill and an "old man" and a press holder is illustrated in Fig. 3. This drill has a spindle with a Morse taper, No. 3, and will handle drills up to 1¼ in. in diameter. These devices are manufactured by the Coates Clipper Mfg. Co., of Worcester, Mass.

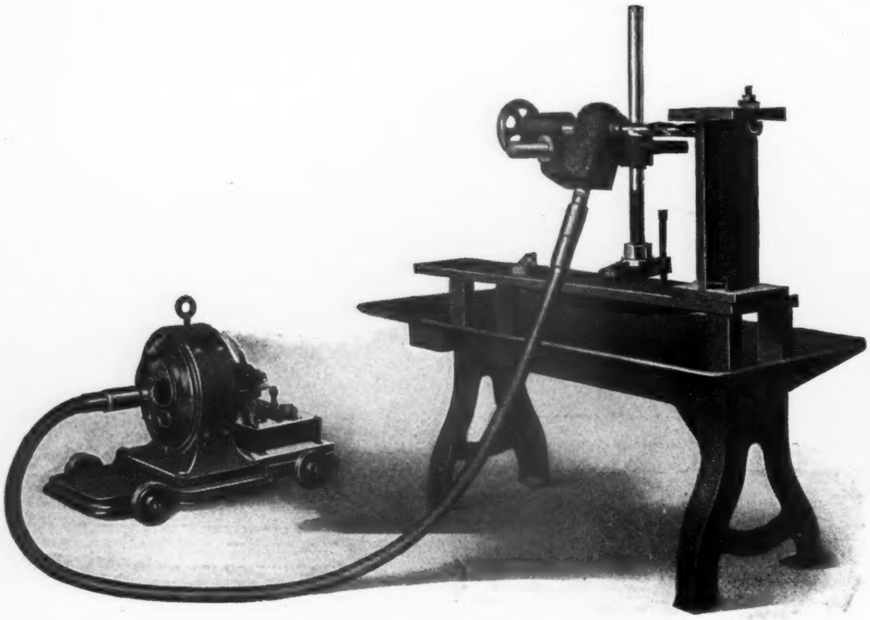


FIG. 3. PORTABLE DRILLING OUTFIT.

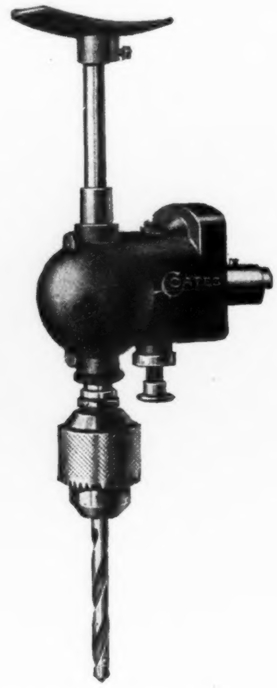


FIG. 2. VARIABLE SPEED BREAST DRILL.

FIG. 1. BREAST DRILL DRIVEN BY AN ELECTRIC MOTOR AND FLEXIBLE SHAFTING.

All-Steel Business Car.—An all-steel business car has been completed at the Altoona shops of the Pennsylvania Railroad for the exclusive use of the executive officers. No wood whatever was used in the construction of the car. It is to be equipped with the usual conveniences, such as typewriters, telephone, desk, maps and statistics, for carrying on the business of the company.

RAILWAY CLUBS.

Canadian Railway Club (Montreal).—At the next meeting, January 4th, there will be a discussion on the revision of the Master Car Builders' rules and the standards of the Master Mechanics' Association.

The annual dinner will be held at the Windsor Hotel on Friday evening, January 28th.

Secretary, Jas. Powell, P. O. Box 7, St. Lambert, near Montreal.

Central Railway Club (Buffalo).—The annual meeting will be held at the Hotel Iroquois on Thursday, January 13th, at 2 P. M. W. O. Thompson, master car builder of the western division of the N. Y. C. & H. R. R. R., will read a paper on "Car Interchange; Its Past, Present and Future."

The annual dinner, which ladies are privileged to attend, will be held at 7:30 P. M. It will be preceded by a reception in the main parlor of the Hotel Iroquois. The attendance of the Hon. Louis Fuhrmann, Mayor-elect of Buffalo, and a number of prom-

inent railroad officials is probable. There will be a musical program with addresses by Frank Hedley, of New York City, vice-president and general manager of the Interborough Rapid Transit Co., and second vice-president of the New York Railroad Club; Col. B. W. Dunn, of New York City, chief inspector, Bureau of Explosives, American Railway Association; E. Chamberlin, of New York City, chairman freight car repair pool, New York Central Lines; E. F. Knibloe, of Buffalo, general agent of the Buffalo Creek Railroad; E. M. Tewkesbury, general superintendent of the South Buffalo Railway, and second vice-president of the club, will be toastmaster.

Secretary, H. D. Vought, 95 Liberty street, New York City.

Iowa Railway Club (Des Moines, Ia.).—Next meeting, Friday, January 14. Secretary, W. B. Harrison, Union Station, Des Moines, Ia.

New England Railroad Club (Boston).—The January meeting will take the form of a dinner at the Hotel Somerset, Boston, Mass., on January 12. The speakers will be Hon. E. S. Draper, governor of Massachusetts; W. C. Brown, president of the New York Central Lines, and Geo. A. Post, president of the Railway Business Association. The general subject of the evening will be the increasing, in New England, of sentiments looking toward conciliation between the public and the railways. W. B. Leach, treasurer and general manager of the Hunt-Spiller Mfg. Corporation, Boston, a former president of the New England Railroad Club and now an executive member of the Railway Business Association, is chairman of the dinner committee.

Secretary, Geo. H. Frazier, 10 Oliver street, Boston, Mass.

New York Railroad Club.—Next meeting, Friday evening, January 21. Subject not yet announced. Secretary, H. D. Vought, 95 Liberty street, New York City.

Northern Railway Club (Duluth).—The paper on "Pooling Locomotives" by C. J. Whereat, traveling engineer of the Great Northern Railway, which was scheduled for the December meeting, will be presented at the next meeting, January 22nd.

Secretary, C. L. Kennedy, 401 West Superior street, Duluth, Minn.

Railway Club of Pittsburgh.—J. R. Alexander, general road foreman of engines of the Pennsylvania Railroad at Altoona, will present a paper, "Supervision Tending to Economy in the Operation of Locomotives," at the next meeting, January 28th. About 60 new members have been received into the club at the last two meetings.

Secretary, C. W. Alleman, P. & L. E. R. R., Pittsburgh, Pa.

Richmond Railway Club.—At the meeting on January 10th, Geo. H. Whitfield, general superintendent of light and power of the Virginia Passenger & Power Company, will present a paper on "Terminal Freight Handling by Electrical Machinery," prepared by H. McL. Harding under the auspices of the International Lecture Institute. This is a description of what has been accomplished by electricity in the movement of miscellaneous freight, including methods of prominent manufacturers, and the requirements which freight handling machinery must fulfil to be acceptable to railway engineers and to others interested in terminal freight.

At the annual meeting in November the following officers were elected: President, H. M. Boykin, division freight agent, Seaboard Air Line; first vice-president, A. H. Moncure, master car builder, Richmond, Fredericksburg & Potomac R. R.; second vice-president, T. M. Ramsdell, master car builder, Chesapeake & Ohio Ry.; third vice-president, J. H. Witt, superintendent, Seaboard Air Line Ry.; secretary-treasurer, F. O. Robinson, C. & O. Ry.

Southern & Southwestern Railway Club (Atlanta, Ga.).—The next regular meeting will be held January 20, at 10 A. M.

Secretary, A. J. Merrill, 218 Prudential Building, Atlanta, Ga.

St. Louis Railway Club.—J. J. O'Brien, supervisor car department of the Terminal Railroad Association, St. Louis, Mo., will speak on "Freight Car Interchange Inspection" at the next meeting, January 14th.

The annual Christmas entertainment was given in the Odeon Theater on December 10th and was attended by the members and their families to the number of 1,700.

Secretary, B. W. Frauenthal, Union Station, St. Louis, Mo.

Western Canada Railway Club (Winnipeg).—"The Stores Department and Its Relations to the Other Departments" will be the subject of the paper for the meeting of January 10th. It will be presented by A. E. Cox, storekeeper of the Canadian Northern Railway.

H. B. Lake, chemist of the Canadian Pacific Railway, read a paper on "Water Service" at the December meeting.

Secretary, W. H. Rosevear, P. O. Box 1707, Winnipeg, Man.

Western Railway Club (Chicago).—Major Chas. Hine, special representative on the staff of the director of maintenance and operation of the Harriman Lines, and who is in charge of the installation of the "Hine" or "Unit System of Organization," will present a paper on "Organization" at the meeting of January 18th.

At the December meeting W. V. Turner, of the Westinghouse Air Brake Company, gave a lecture, illustrated with lantern slides, on "Brake Manipulation in General Freight Service. A Review of Some of the Causes and Conditions Which Produce Shocks and Break-in-Twos."

Secretary, Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

BOOKS.

Manual for Engineers. Compiled by Prof. Chas. E. Ferris and published by the University of Tennessee, Knoxville, Tenn. Vest pocket size. Price 50 cents.

This is the thirteenth edition; matter used in former editions that seemed to be somewhat obsolete has been replaced by new material. It contains a large amount of data and tabular matter, conveniently arranged for ready reference.

Railroad Pocket Book. By Fred H. Colvin. Second edition. 4 by 6 inches, illustrated, paper bound. Published by The Norman W. Henley Publishing Company, 132 Nassau street, New York City. Price, $1.00.

The information is arranged alphabetically in the form of a dictionary and will be found very convenient for ready reference. It relates largely to the work of the motive power department and is illustrated with a large number of line drawings.

Locomotive Breakdowns and Their Remedies. By Geo. L. Fowler and revised by Wm. W. Wood. Pocket edition, paper cover, 270 pages. Price, $1. Published by The Norman W. Henley Publishing Company, 132 Nassau street, New York City.

The principal change in this, the sixth revised edition, is that the air brake chapter has been rewritten and a chapter of useful rules and information has been added. Walschaert valve gear troubles and the electric headlight are treated in detail.

The "Mechanical World" Pocket Book and Year Book for 1910. Published by Emmott & Co., Ltd., 65 King street, Manchester, England. Price, 15 cents net.

This is the twenty-third edition and contains a collection of engineering notes, rules, tables and data occuping about 230 pages (3¾ x 6 in.). There is also a complete index and about 60 pages for a diary for 1910. The low price of the book is explained by a number of additional pages containing advertisements. A considerable amount of new matter has been added

and a thin, tough paper has been used, effecting a considerable reduction in the bulk.

First Annual Report of the Board of Supervising Engineers of Chicago Traction. Published by the Board, Chicago, Ill. 462 pages; 5¾ in. by 8¾ in.; cloth.

The Board of Supervising Engineers is made up of Bion J. Arnold, chairman; George Weston, representing the city of Chicago; Harvey B. Fleming, representing the Chicago City Railway Company; John Z. Murphy, representing the Chicago Railways Company, and F. K. Parke, secretary and auditor. The report is for the period ended January 31, 1908, and is designated as the first annual report. It covers the present condition of the traction systems thoroughly and, of course, to a certain extent outlines the course to be followed in the future.

Betterment Briefs. By Henry W. Jacobs, Assistant Supt. Motive Power, Atchison, Topeka and Santa Fe Railway. 262 pages. 151 illustrations. Published by John Wiley & Sons, New York City. Price, $3.50.

The first edition of this book, which is a collection of published papers on organized industrial efficiency, was prepared by Mr. Jacobs for private circulation and was reviewed at considerable length in the June, 1908, issue of this journal, page 228. The new edition has been revised and enlarged in a manner which may be best described in the words of the preface, prepared by Charles Buxton Going, of *The Engineering Magazine:*

"Meanwhile (since the first edition) the work on the Santa Fé was proceeding to the development of a new order—new, not only to the road, but to the ideals of railroad operation generally. In the mechanical and stores' departments, in the apprenticeship system, and in all the relation with employees, both financial and friendly, standards were being attained which made the Santa Fé a center of observation and study for railway officials throughout the country. Both inside and outside the organization in which Mr. Jacobs was directing so strong a motive force, there was need for a logical presentation of the various aspects and activities of the betterment work—a presentation which should properly correlate the several influences and agencies and show them in their proper proportion and connection with one another.

"This book appears as the fulfilment of the need. While it is recrystallized from a portion of the original material, it is a segregation of the best elements contained therein, strengthened and amplified by a great store of new matter amply sufficient to display the present status of betterment work and to advance its fuller development. It has been prepared at the very focus of the energies with which it deals, and it reflects the actualities as they appear in the daily prosecution of the movement for higher efficiency and better economy in the conduct of a great railway. Above all, it expresses the strong vitality, the watchful intensity, the wide activity, and the energizing personal enthusiasm of its author."

Locomotive Dictionary. Revised 1909 edition. Compiled for the American Railway Master Mechanics' Association by Geo. L. Fowler. 670 pages, 9 in. by 12 in.; 5,266 illustrations. Price, $6. Published by the *Railroad Age Gazette,* New York and Chicago, and by the *Railway Gazette,* London.

The first edition, issued three years ago, has been thoroughly revised. Considerable care has been taken to exclude those designs that have become obsolete. Devices which are still in an experimental stage have also been omitted. This and the fact that the illustrations are exceptionally good makes the volume of special value to those interested in locomotive design and maintenance.

Through an oversight the American Engineer and Railroad Journal was not properly credited with certain information which was used, but the publishers promptly acknowledged this when they discovered the error, as may be seen from the following extract from their review of the book: "In the latter part of the volume the exhibit of machine tools for locomotive shops is designed to cover the latest and most approved practice. In this connection there is given a study by the distinguished mechanical engineer, L. R. Pomeroy, of the machine tool operations required, working eight hours a day, in making four new consolidation locomotives, eight light repairs and 30 general repairs per month at the Scranton shops of the Delaware, Lackawanna & Western Railroad. It is a thorough piece of work, of high value to any officer looking for shop economies. It might be called an unrelenting piece of work. In an analysis of the results to be expected from machine tools, Mr. Pomeroy has favored no one. In presenting this study, with Mr. Pomeroy's permission, the publishers owe and desire to make a sincere apology for a failure to credit the first serial publication of Mr. Pomeroy's work to the American Engineer and Railroad Journal. The files of this widely known monthly railway publication were of frequent value to the compiler in obtaining information of new designs."

Railroad Structures and Estimates. By J. W. Orrock, C. E. 270 pages, 6 by 9 inch, cloth. Price, $3. Published by John Wiley & Sons, 43 East 19th street, New York City.

It was the intention of the author to cover in a brief and concise form the subjects which enter into the engineer's estimates of railroad building for the purpose of ready reference, as to general construction and cost, on a business rather than a technical basis. As it is impossible to give data to suit all conditions, the weights, quantities, and cost are given in detail in most instances and may be varied as desired.

The sections of special interest to mechanical department readers are those on engine houses, boiler houses, storehouses, oil houses, coaling stations, ash pits, sand houses, turntables and shops.

PERSONALS.

E. H. Diehl has been appointed traveling engineer of the middle division of the Pennsylvania R. R.

T. H. Yorke has been appointed master mechanic of the Chicago Great Western, with office at Des Moines, Iowa.

R. G. Cox has been appointed master mechanic of the Virginia & Southwestern Ry. to succeed A. J. Dunn.

W. J. Bennett, assistant superintendent of motive power of the Chicago, Indianapolis & Louisville, with office at Lafayette, Ind., has resigned.

John U. Mock has been appointed purchasing agent and assistant treasurer of the Denver, Laramie & Northwestern, with office at Denver, Colo.

N. M. Maine, general master mechanic of the Chicago, Milwaukee & Puget Sound at Deer Lodge, Mont., has been transferred to Tacoma, Wash.

C. M. Stansbury, master mechanic of the Boca & Loyalton at Loyalton, Cal., has been appointed master mechanic of the Western Pacific, with office at Elko, Nev.

G. E. Johnson, master mechanic of the Chicago, Burlington & Quincy at Wymore, Neb., has been appointed general master mechanic, with office at Lincoln, Neb.

J. J. Thomas, Jr., has been appointed superintendent of motive power and car equipment of the Mobile & Ohio, with office at Mobile, Ala., succeeding G. S. McKee, resigned.

John C. Stuart, general manager of the Erie Railroad, has been made vice-president of that road, in charge of the operating, maintenance and mechanical departments.

David Van Alstyne, vice-president of the American Locomotive Company, in charge of manufacture, has resigned.

Thomas Kuhn has been appointed to succeed the late W. J. Ritchie as foreman boilermaker of the Erie's grand division and the New York, Susquehanna & Western, at Jersey City.

Michael W. Hassett has been appointed master mechanic of the New York Central & Hudson River, with office at East Buffalo, N. Y., succeeding F. M. Steele, transferred to Rochester.

C. L. Buchanan has been appointed general storekeeper of the National Railways of Mexico, with office at San Luis Potosi, Mex., succeeding Charles O'Brien, resigned on account of ill health.

E. J. McMahn, general foreman of the Illinois division of the Iron Mountain at Dupo, has resigned to become master mechanic on the Raton Mountain division of the A., T. & S. F. Ry.

C. B. Foster has been appointed general storekeeper of the Toledo, St. Louis & Western, the Chicago & Alton, the Iowa Central and the Minneapolis & St. Louis, with office at Bloomington, Ill.

F. S. Anthony, master mechanic of the International & Great Northern at Palestine, Tex., has been appointed superintendent of machinery, with office at Palestine, succeeding J. F. Enright.

Benjamin Johnson, formerly superintendent of motive power of the Mexican Central, has been appointed superintendent of motive power of the United Railways of Havana, with office at Havana, Cuba.

James W. Stuart, assistant general storekeeper of the Chicago, Burlington & Quincy, has been appointed temporary general storekeeper, with office at Chicago, succeeding Thomas A. Fay, deceased.

George S. McKee, superintendent of motive power and car equipment of the Mobile & Ohio, with office at Mobile, Ala., has resigned. He will continue with the company for some months in an advisory capacity.

J. H. Race has been appointed a master mechanic of the Oregon Short Line, with office at Pocatello, Idaho. He will have charge of the Pocatello shops, including the roundhouse and car department forces.

F. L. Allcott having resigned as engineer of tests of the Chicago, Milwaukee & St. Paul, J. F. De Voy, mechanical engineer, will assume charge of the testing department, in addition to his other duties. Mr. Allcott has gone with the Buckeye Steel Castings Company at Columbus, Ohio.

John M. Lammedee, a graduate of the mechanical engineering department, Purdue University, has resigned the position which he has held for several years in the test department of the Pennsylvania R. R. at Altoona, and joined the editorial staff of *The Railway & Engineering Review*, at the Chicago office.

James W. Friend, of Pittsburgh, died on December 26 at 10.45 P. M. after a lingering illness. He was 64 pears old. Mr. Friend was a familiar figure in the iron, steel and coal industries and among the banking interests of Pittsburgh, having been vice-president of the Pressed Steel Car Company, the Western Steel Car & Foundry Company, one of the owners of the Clinton Iron & Steel Company, vice-president of the German National Bank of Allegheny, and a director in the Farmers' Deposit National Bank of Pittsburgh. The funeral took place on December 29 at 2.30 P. M. from his late residence in Pittsburgh.

Peter H. Peck, for more than 20 years master mechanic of the Chicago & Western Indiana, was struck by a freight train at Seventy-ninth street, near Grand Crossing, Chicago, on November 28, and was so badly injured about the head that he did not regain consciousness and died that evening. A sketch of his career was published in the December, 1909, issue of this journal.

M. H. Haig has been appointed mechanical engineer of the Atchison, Topeka & Santa Fe, with office at Topeka. Mr. Haig was graduated from Cornell University in 1900 and immediately after graduating began railway work with the Illinois Central as a machinist apprentice. He was later a machinist and afterwards a foreman. He resigned in April, 1906, to become editor of the *Railway Master Mechanic*. In February, 1909, he was appointed betterment assistant on the Santa Fe, where he was engaged in work of the bonus department.

H. E. Rouse has been appointed general storekeeper of the Chicago Great Western. He was born August 7, 1868, at Morning View, Ky., and began railway work in March, 1887, with the Cincinnati, New Orleans & Texas Pacific as clerk in the office of the superintendent of motive power and machinery. Later in the same year he was transferred to the accounting department, where he remained six years. He was made chief clerk to the master mechanic and division storekeeper at Chattanooga, Tenn., in September, 1893. In February, 1900, he went with the Chicago & Alton, where he was consecutively, until his recent appointment, chief clerk and accountant for the maintenance of way department, chief clerk and accountant for the motive power department, and general storekeeper, with office at Bloomington, Ill. Mr. Rouse's headquarters will be at Oelwein, Iowa.

Samuel Garver Thomson, who has been appointed assistant engineer of motive power of the Philadelphia & Reading and subsidiary companies, with office at Reading, Pa., was born November 19, 1875, at Cumberland, Md. He was graduated from the Lawrenceville school in 1894 and from Princeton University in 1898. In October of the same year he began railway work with the Pennsylvania and later up to 1902 was a special apprentice at Altoona, Pa. He was then appointed motive power inspector at Altoona, Pa., since which time he has been consecutively general foreman at State Line, assistant master mechanic at Harrisburg, assistant engineer of motive power at Buffalo, N. Y., and later assistant engineer of motive power at Philadelphia, Pa., with the same company. He was appointed assistant engineer of motive power on the Philadelphia & Reading, November 15, 1909.

Dr. C. B. Dudley, chemist of the Pennsylvania Railroad, died at Altoona, Tuesday, December 21. He was born July 14, 1842, at Oxford, N. Y., and was educated at Oxford Academy and Yale University. He was graduated from the academic department of the latter institution in 1871 and from Sheffield Scientific School in 1874. For one year he served as assistant to the professor of physics at the University of Pennsylvania. In 1875 he entered the service of the Pennsylvania Railroad as chemist, which position he held to the time of his death. He was twice elected president of the American Chemical Society and was extremely active in the work of the American Society for Testing Materials. He was several times elected president of this latter society and the important position it occupies at the present time is largely due to his efforts. At the close of its convention last July he was chosen as the official delegate to represent the society at the International Congress for Testing Materials at Copenhagen, Denmark. He was elected president of the International Congress which is to meet in this country in 1912. Dr. Dudley served in the One Hundred and Fourteenth New York Volunteers during the Civil War and was severely wounded in the battle of Winchester, September 19, 1864. He was one of the most prominent scientists in the country and his loss will be widely regretted.

CATALOGS.

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

HEATING SYSTEMS.—"The Selection of a Heating System" is the title of a booklet issued by Warren Webster & Co., Camden, N. J. The Webster Modulation system of steam heating is described and attention is directed to its advantages.

UPRIGHT DRILLS.—J. E. Snyder & Son, Worcester, Mass., have prepared a neat 52-page catalog describing the upright drilling and tapping machines manufactured by them. These drills are from 20 to 36 in. in size and may be equipped with either a belt or motor drive.

MOTOR-GENERATOR SETS.—The functions of the motor-generator set and the methods of choosing the motor-generator best adapted for each condition have been clearly outlined in Bulletin No. 116, published by the Crocker-Wheeler Company, of Ampere, N. J.

FLOATING REAMER HOLDER.—A new floating reamer holder for use in vertical boring mills with turret heads, and which holds any make or style of reamer with Morse taper shank, is described in a circular received from the Colburn Machine Tool Company, Franklin, Pa.

CONVEYING MACHINERY.—Catalog 81 from The Jeffrey Manufacturing Company, Columbus, Ohio, contains general price lists and descriptions of the elevating, conveying and power transmitting machinery, and chains manufactured by them. It contains 368 pages.

SMALL DIRECT CURRENT MOTORS.—Bulletin No. 118 from the Crocker-Wheeler Company, Ampere, N. J., describes their Form L motors which have a capacity of 1/20 to 7½ h. p. A number of typical applications of these motors are illustrated. The last page contains considerable engineering information of value to motor users.

FURNACES.—Bulletin G from the Rockwell Furnace Company, 26 Cortlandt street, New York City, describes both their underfired and overfired furnaces for hardening, tempering, case hardening and annealing tools, etc. A portable accurate temperature furnace using oil fuel; also a complete oil burning outfit and oil or lead bath tempering furnaces with either gas or oil fuel are illustrated and described.

"GRAPHITE AS A LUBRICANT."—The eleventh edition of this well-known publication of the Joseph Dixon Crucible Company, Jersey City, N. J., is ready for distribution. The present edition is more compact than its predecessors, the idea being to concentrate the information into a convenient form for ready reference and not be too bulky. The use of larger type and wider margins greatly improves the appearance of this new edition.

WROUGHT IRON VS. STEEL PIPE.—The Reading Iron Co., Reading, Pa., is issuing the eighth edition of a pamphlet which is in the form of a brief for the plaintiff before a court and contains a full argument why wrought iron is better than steel in resisting corrosion of pipes. It contains extracts of letters from users, articles from technical papers and similar information. The pith of the argument is that the presence of silicate of iron in wrought iron is the reason of its better resistance to corrosion. This pamphlet is most interesting and instructive.

"THE DAWN OF A NEW ERA IN LIGHTING."—In a very attractive pamphlet the General Electric Company takes up the history of light from the tallow dip to the latest development in artificial lighting—the tungsten lamp. Following this historical sketch is a description of the tungsten lamp, its efficiency, cost of operation and various applications of the lamp in interior lighting. The comparison of cost of this with other illuminants is taken up in considerable detail. The pamphlet, which is numbered 3885, is of interest to both the producer and consumer of current.

STEAM TURBINES FOR LOW PRESSURE AND MIXED PRESSURE.—Bulletin No. 4705, devoted to the above subject, has been issued by the General Electric Company. The publication deals with turbines of both the low pressure and the mixed pressure types, and those with horizontal and with vertical shafts. Two cases are considered: First, turbines in connection with engines that are run non-condensing; second, in connection with condensing engines. Horizontal turbines of this type are built with capacities of from 300 to 2,000 k. w., and 25 and 60 cycles. Those of 300 and 500 k. w. capacity are also built for direct current. The 5,000 and 7,000 k. w. turbines are vertical and for alternating current only.

SAFETY VALVES.—The Consolidated Safety Valve Company, 85 Liberty street, New York City, has done very effective work in connection with the rating and specifying of safety valves according to their actual relieving capacities, and in increasing their efficiency by modifications in design which made possible the obtaining of larger capacities and a cleaner, more positive action. A cloth bound catalog has been received from this company; it opens with a brief discussion of safety valve capacity and a description of tests that have been made in investigating the subject. Then follows a description of the various designs manufactured by them. Much space is given to valves especially designed and developed for locomotive service.

ASBESTOS PROTECTED METAL.—The Asbestos Protected Metal Company, Canton, Mass., has prepared a catalog which describes in detail the composition of its product and considers at length the various uses for which it is adapted. It is of special interest to the railroads in connection with roofing and siding of buildings, shops and coal tipples; also box car roofing, and roofing, headlining and paneling for steam and electric passenger cars, etc.

INSULATION OF PIPES AND BOILERS.—This is the title of a booklet received from H. W. Johns-Manville Company, 100 William street, New York City. Among the J-M sectional pipe coverings which are illustrated and described are Asbestos-Sponge Felted, Asbestos Fire-Felt, Magnesia, Vitribestos, Asbestocel, Air-Cell, Moulded Asbestos, Wool Felt, Anti-Sweat, Eureka and Zero. Other coverings are the Keystone plumbing pipe covering which prevents dripping and freezing of plumbing pipes, Safety Blow-Off sectional pipe covering for blow-off pipes, Asbestocel corrugated fireproof paper for covering heater pipes, etc., Asbestos Roll Fire-Felt, and sheets and blocks for boilers, boiler flues, heaters, etc. Asbestos and magnesia cements for use with these coverings are described and directions are given for applying them.

WOOD-WORKING MACHINERY.—Catalog L from The Bentel & Margedant Company, Hamilton, Ohio, describes the well-known line of Hamilton-Ohio-Line wood-working tools. It is arranged in a neat and compact form, containing about 200 pages and being 4 x 6¾ in. in size. The illustrations while small are clear-cut and show up the details splendidly. The illustrations are on the left hand page with the description opposite. Some idea of the extent of the catalog may be gained from the fact that it contains almost 200 illustrations.

A number of the tools described have been specially designed for use in car shops. They include car mortisers, car gainers, car borers, car tenoners, car saws and car planers, jointers, wood workers, etc.

HORIZONTAL AND VERTICAL MILLING MACHINES.—The Cincinnati Milling Machine Company, Cincinnati, Ohio, has prepared a new 160-page, standard size, 6 x 9 in. catalog, describing the various lines of horizontal and vertical milling machines made by it. The catalog opens with a carefully prepared and thoroughly, as well as handsomely, illustrated description of the important details of these machines. Then follows illustrations and specifications of each size and type of miller.

A number of pages are used for describing typical examples of rapid milling. Fifty pages are required to illustrate and describe the various attachments used. The book closes with notes concerning the erection and care of millers, and speed tables for high speed steel cutters. These tables are based on a surface speed of 40 feet per minute for annealed tool steel, 80 feet per minute for cast iron and machinery steel, and 120 feet per minute for bronze and brass castings.

A carefully prepared index and the placing of the subjects under discussion in heavy type on the margin of the page make the catalog of special value for reference purposes. Summed up it may be designated as a high grade text book on milling machines.

Some important improvements have been made on the No. 1½, 2 and 3 cone-driven machines, especially in the design of the column and the feed mechanism. The column is very similar to that used on the high power machines, in that it is a complete box in form and contains the entire feed mechanism.

NOTES

THE Q M S Co. (Quincy, Manchester, Sargent), desires to announce that on January 1st they will move their western office from 1775 Old Colony Building to 738 First National Bank Building, Chicago. Their interests in the west will hereafter be taken care of by John C. Hoof.

Q. & C. COMPANY.—G. C. Isbester has been elected vice-president of the Q. & C. Co., and F. F. Kister, treasurer. Mr. C. F. Quincy remains president as heretofore. This company handles the Bonzano rail joint, Q. & C. and National step joints, Q. & C. insulated joint and Anti-rail creepers, guard rail clamps, guard rail braces, Q. & C. portable rail saw, Q. & C. Samson rail-bender, Maxwell deformed bar, Kimball concrete tie and Bailey lining and surfacing blocks. The western office in charge of vice-president Isbester, will be in the Old Colony building, Chicago.

PAUL M. CHAMBERLAIN announces that he has opened an engineering office at 1522 Marquette Building, Chicago. Mr. Chamberlain was graduated from the Michigan Agricultural College in 1888, and from Cornell University in 1890. For several years he was in practical work with the Brown Hoist Company, of Cleveland, Ohio; the Frick Company, engineers, of Waynesboro, Penn.; the Hercules Iron Works, of Aurora, Ill.; and then accepted the assistant professorship at the Michigan Agricultural College. At the opening of the Lewis Institute, in Chicago, he took charge of the engineering work and brought it up to its well-known standard of excellence. During his connection with the Lewis Institute he carried on much consulting work with special reference to power production and factory methods. He resigned this position to act as consulting engineer for the McCan Mechanical Works, of Los Angeles, Cal. Later he accepted the position as chief engineer of the Under-Feed Stoker Company of America, where for the past two years and a half he has made a special study of boiler room equipment, economy in fuel burning and smoke abatement. He will devote his time to new designs and improvement of existing installations.

THE ELECTRIFICATION OF TRUNK LINES

L. R. POMEROY.

We are fortunate in being able to present one of the clearest and most logical discussions of the problem of the electrification of trunk lines that has thus far been made. The electrical engineer in discussing the problem has lost sight of many important considerations in connection with the maintenance and operation of the steam locomotive. He has assumed that the tonnage moved was limited by the capacity of the locomotive and has lost sight of the fact that it was controlled by operating conditions, terminal facilities etc.—conditions that will affect the electric locomotive in the same way. The great expense of replacing steam by electricity and the resulting heavy fixed charges have not been given proper emphasis. Mr. Pomeroy has been eminently fair to the electric locomotive and has conservatively stated the case of the steam locomotive; it is believed that his statements will have much to do in clearing away the haze on this subject in the minds of many of our readers, caused to some extent by the many electrical terms—volts, amperes, cycles, alternations, phases, etc., etc.—that usually accompany the arguments of the electrical engineer. These notes are the basis of an address recently given by Mr. Pomeroy before the Engineering Society of Columbia University, New York City.

It is assumed that, from a physical and mechanical viewpoint, electric traction can meet all the demands and requirements of railroad service. Therefore, whether electricity will replace steam traction or not, is entirely a commercial problem.

COMMON DENOMINATOR = COMMERCIAL CONSIDERATIONS*

Electrification Handicapped by Large Outlay.—It may be stated at the outset that whatever system of electrification is adopted, a very large outlay has to be faced and no case for electrification can be made out *unless an increase in net receipts can be secured sufficient to more than pay interest on the extra capital involved.* This increase may be brought about either by decreasing the working expenses for the same service, by so modifying the service as to bring in a greater revenue, or by a combination of these.

Some Sections of Roads Now Operated by Steam Could be Handled Better by a Light Trolley Service.—However, there is hardly a steam road in existence to-day which does not have divisions or sections, where distinctly local traffic can be handled more profitably by light, comparatively frequent electric service, than as now, with heavy steam trains.

Steam and Electric Service Can Be Operated on the Same Track.—Both steam and electric service can be operated over the same tracks without detriment or embarrassment to either. In so doing each kind of service would be appropriately handled in a manner best suited to the conditions of each.

The fundamental principle, based on the present state of the art, seems to be, that if you cannot accomplish something by means of electricity that is now impossible by steam traction, there is nothing to justify the change; the mere substitution of one kind of power for another, merely to obtain the same result, is not commercially warranted.

An Inherent Advantage of Electricity Not Available for Trunk Line Service.—There are certain inherent advantages in electrical operation that have shown up advantageously, because the increase in business has absorbed the increased interest account, but these cases hardly apply to trunk line conditions as the law of induced travel has no bearing on freight train operation, the principal business of trunk line roads.

Boiler the Limiting Feature of the Steam Locomotive.—In heavy work the limiting feature of the steam locomotive is the boiler, and the maximum adhesion can be utilized only at low speeds. For example, a 2-8-0 locomotive with 180,000 pounds on the drivers, has a tractive force, at 10 miles per hour, of about 40,000 pounds, or 4.5 to 1. At 30 miles per hour the tractive force becomes 13,250 pounds, or 30.2 to 1. As tractive force governs the tonnage hauled, the ability of the electric locomotive to utilize almost indefinitely power proportional to the maximum adhesion and produce a drawbar pull entirely independent of the critical speed of a steam locomotive, as limited by the boiler, is a marked feature.

Electric Locomotive Valuable for Heavy Grade Work.—In heavy grade work the ability to increase the speed shows up favorable to the electric locomotive as enlarging the capacity of a given section, but here also the business has to be sufficient to absorb the increase in fixed charges.

Coal Consumption of Steam Locomotive per Horse Power Hour.—With steam locomotives a coal consumption, when running, of 4 to 5 pounds per indicated horse-power really means 6 or 7 pounds at the rail, when the losses due to firing up, laying by in yards and sidings, blowing off at the pops, and consumption of the air pumps, is taken into account. Whereas, under electric operation, with an efficiency of 65 to 70 per cent. between the power house and the rail, a coal consumption of 4 pounds per kilowatt hour at the rail can be counted on.

Cost of Power for Electrical Operation.—The writer is informed that the Metropolitan Street Railway station (1903) with a 40 per cent. load factor, produced power, at the switchboard,

* Recently the *Engineer* (London) editorially made a plea for a "Common Denominator" for comparison of engineering achievements, using the following illustrations:

"Thus for example, if we take Mr. Humphrey's reply to Mr. Davey's criticisms, we see that he gained a mere dialectical advantage by showing on the screen a great differential pump, and beside it an internal combustion pump, so small by comparison that he had to explain that it was not a "hooter." Both engines could deal with the same quantity of water; but the Davey engine was lifting it 1,500 ft. from a mine, while the gas pump could not lift it more than about 15 ft. Indeed, it could not do the work of the Davey engine at all."

Also a comparison was drawn between the cost of working with producer gas engines and steam engines. The argument was all in favor of the gas engine, expressed in weight of fuel required per hour to develop a horse-power. But the aspect of the matter changed when it was pointed out that the coal used by the steam engine was slack, costing $1.75 per ton, while the gas producer worked with anthracite, costing over $6.25 a ton. Here the cost of fuel was the common denominator, not the weight of the fuel.

The plea concluded by saying that the common denominator should be the Commercial Cost. E. H. McHenry expressed the same idea when he said that "Engineering was making a dollar earn the most interest."

at the rate of 4.7 mills per kilowatt hour (or 3.5 mills per horsepower hour) and with a load factor of 55 per cent. which prevails in the winter time, the cost is at the rate of 4.43 and 3.3 mills respectively. These costs cover all expenses and repairs except fixed charges. The coal consumption is 2.9 pounds per kilowatt and 2.16 per horse-power hour.

L. B. Stillwell is authority for the statement that the Interborough is producing power at the rate of 2.6 pounds of coal per kilowatt hour or 3 pounds at the drawbar.

Another authority gives the following figures for the elevated roads for cost of power, $0.005 per kilowatt hour at the switchboard, $0.0066 at the third rail shoes, or $0.0089 at the rims of the drivers. These figures are exceptional and hard to duplicate and as the fixed charges are not included, the writer *would consider 1¼ cents per kilowatt hour at the rail a conservative figure and will use this cost in the following computations.*

Relative Cost of Coal for Steam and Electrical Operation.—It may be fair to assume that where average coal is used, we can count on about $2.25 per ton for locomotive coal on the tender, while a much cheaper grade can be used in the power house, costing, with modern coal handling facilities, about $1.50 per ton. At this rate the relative difference in the cost of coal at the rail would be represented by the following figures:

Electric Power Station $\frac{2.5 \text{ lbs.}}{60\% \text{ eff.}} \times \$1.50$	$7.50
Steam Locomotive 7 × $2.25	$15.75

or 50 per cent. in favor of electricity. The following results of the Mersey Tunnel operation are pertinent: Under electric operation one ton of coal at $2.10 yields 2.29 ton miles at 22½ m.p.h., while with steam, one ton of coal, at $3.84, yields 2.21 ton mines at 17¾ m.p.h. The difference amounts to 55 per cent. in favor of the electric operation.

$$\left[1-\frac{2.10}{3.84}\right] \times \frac{22.5}{2.29} \div \frac{17.75}{2.21} = \left[1-\frac{2.10}{3.84}\right] \times \frac{22.5 \times 2.21}{2.29 \times 17.75} = 55\%$$

Advantage in Cost of Fuel for Electricity Still Greater on Mountain Grades or in Heavy Freight Service.*—While perhaps the difference in cost does not become so great, in ordinary working of low grade lines, although some of the most powerful passenger locomotives in the country are used on such lines, yet on mountain grades or in heavy freight service, where the boiler of the freight locomotive is forced to the limit, and the boilers are designed for this particular purpose, the showing is more favorable to the electric side; especially when the steam locomotive is detained on side tracks as long a period as it takes to make the run, which is very frequently the case, as under these conditions the cost for fuel becomes a larger proportion of the total operating expense. A 2-8-0 locomotive with 50 square feet of grate surface burns 300 pounds of coal per hour while lying on side tracks. Reports from Mallet locomotives indicate that from 600 to 800 lbs. are burned per hour.

The cost of a unit of power, with the steam locomotive, becomes relatively higher under maximum than minimum boiler demands, while with electricity the cost per unit is at a uniform rate, whether working under extreme or light power demands.

For example:

Case 1. A consolidation (2-8-0) type locomotive with 180,000 pounds on 57 inch drivers, 50 square feet of grate surface, working under maximum conditions on a 1½ per cent. grade, would burn 150 pounds of coal per square foot of grate surface per hour and evaporate from 12 to 15 pounds of water per square foot of heating surface per hour.

Under these conditions the cost per 1,000 ton miles would figure out as follows:

$$\frac{\text{F} \times \text{price per ton} \times \text{R} \times 1000}{2000 \times \text{M.P.H.} \times \text{E} \times \text{TF}} = \text{Cost per 1,000 ton miles.}$$

where F = coal per hour (150 lbs. × 50 sq. ft. of grate surface).
R = resistance to be overcome [(grade per cent. × 20) plus 6].
E = 80 per cent. efficiency to cover losses such as cleaning fires, idle time while under steam, cylinder condensation, air pump consumption, etc.
TF = tractive force, in this case 180,000 lbs. on drivers ÷ 4.5 = 40,000 lbs.

Substituting these values, the formula becomes:

$$\frac{7{,}500 \text{ lbs.} \times \$2.85 \times 36 \times 1{,}000}{2{,}000 \times 10 \times 80\% \times 40{,}000} = \$1.20$$

If the same service is handled by electric locomotives, the cost on a similar basis becomes:

$$\frac{\text{R} \times (\text{watt hrs. per ton mile}) \times 1{,}000 \text{ tons} \times \text{price per kw. at the rail}}{1{,}000 \text{ watts}}$$

$$= \frac{36 \times 2 \times 1{,}000 \times \$0.01\tfrac{1}{4}}{1{,}000} = \$0.90$$

If locomotive coal is taken at $1.70 per ton (the price in eastern Pennsylvania for low grade soft coal), the cost for coal for locomotives under the foregoing conditions would be:

(a) Steam, $\frac{\$1.20 \times 1.70}{2.85} = \$0.716$

(b) Electric current reduced to 1c. per kw. hour at the rail:

$$\frac{0.90 \times 1\text{c.}}{1\tfrac{1}{4}\text{c.}} = \$0.72$$

Case No. 2. An express passenger locomotive of the Atlantic (4-4-2) type, with the following data: Cylinders 21x26 inches, boiler pressure 200 pounds per square inch; weight on drivers 102,000 pounds, heating surface 2,821 square feet, grate surface 50 square feet, rate of combustion 150 pounds per square foot of grate surface per hour, speed 70 miles per hour. Figuring as in Case No. 1:

$$\frac{7{,}500 \times 2.85 \times 20 \times 1{,}000}{2{,}000 \times 70 \times 80\% \times 5{,}350} = \$0.71$$

Under electric conditions we have:

$$\frac{20 \times 2 \times \$0.01\tfrac{1}{4} \times 1{,}000 \text{ tons}}{1{,}000 \text{ watts}} = \$0.50$$

or 28½ per cent. less.

If coal is taken at $1.70 per ton, as in Case 1, the cost is reduced from $0.71 to $0.42, making the difference slightly in favor of steam.

These figures apply only to the conditions named, and average conditions, on an undulating profile, when coasting is occasionally possible, and also with the benefits of momentum grades, the figures would be relatively less, but the electric locomotive will respond and benefit accordingly, so that the percentages given would be approximately the same.

When steam locomotives are loaded to their capacity, as is generally the case where tonnage rating is practiced, the rate of combustion of 150 pounds of coal per square foot of grate surface per hour, will still hold good and remain constant, the tons hauled being the variable, responding or being modified by the speed or physical conditions of the road.

Savings Claimed for Electrification.—In view of the foregoing the following extract from an article by Mr. C. L. De Muralt will be of interest; the figures given are from the annual report of 1903 of the roads named:

COST OF OPERATING TRUNK LINES.

	P. R. R.	N. Y. C.
Fuel for locomotives	$6,000,135	$4,635,877
Water " "	335,286	295,583
Other supplies for locomotives	382,548	334,673
Wages:—		
Engine men and roundhouse men	5,716,848	4,928,443
Other train men	4,442,127	2,991,535
Switchmen, flagmen and watchmen	3,900,427	2,511,552
Other exp. conduct. transp	14,540,542	11,607,538
Repairs to locomotives	4,412,983	3,608,972
" other equipment	10,674,726	5,661,992
" roadbed	8,542,935	6,145,341
" structures	4,122,018	2,454,691
General expenses	1,858,319	1,786,494
	$64,928,894	$46,962,491

Mr. De Muralt then applies the figures found during the

* Commenting on the problem of electrification of the Central Pacific over the Sierras, Mr. Kruttschnitt says: "Eastern critics may be inclined to the opinion that we are dallying with this matter. We have found that it pays well to make haste slowly with regard to innovations. Electrification for mountain traffic does not carry the same appeal that it did two years ago. Oil burning locomotives are solving the problem very satisfactorily. Each Mallet compound locomotive, having a horsepower in excess of 3,000, hauls as great a load as two of former types, burning 10 per cent. less fuel and consuming 50 per cent. less water."—*Wall Street Journal*

course of his investigation, which would lead to the following reductions if electricity was adopted as a motive power:

	P. R. R.	N. Y. C.
Fuel 10% or	\$600,013	\$463,388
Water saved entirely	335,286	295,583
Other supplies 50%	191,274	167,336
Wages enginemen, etc., 25%	1,429,212	1,207,361
Repairs to locomotives	2,206,492	1,804,486
Total amount saved	\$4,762,277	\$3,942,154

The *saving in water alone capitalized* at 5 per cent. equals \$6,750,000 for the former and nearly \$6,000,000 for the latter road. *As large as these alleged savings are, yet they would not amount to more than 2½ to 3 per cent. on the necessary increase in capital to electrify the roads on which the foregoing savings apply.*

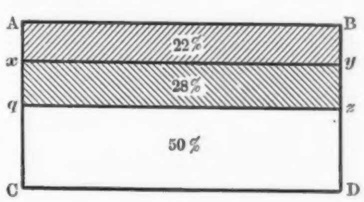
Cost of Repairs of Steam and Electric Locomotives.—While the first cost for power stations and electric equipment represents a large outlay, yet such items as the cost for repairs of locomotives and shops, expensive hostlering at terminals, coaling and water stations and the incidental labor charge and repairs thereto will, in the aggregate, be materially reduced. The comparative saving in repairs will be indicated by the following figures:

Repairs.	Steam.	Electric.
Boiler	20%	0
Running gear	20%	20%
Machinery	30%	15%
Lagging and painting	12%	5%
Smoke box	5%	0
Tender	13%	0
	100%	40%

Comparative Mileage of Steam and Electric Locomotives.—It is further claimed that, with electric operation, greater mileage is possible with the electric locomotive and that fewer units are necessary to perform the same service. Great stress is laid on the fact that the ordinary freight locomotive only makes 3,000 miles per month, or 100 miles per day, against which is put forward the ability of the electric locomotive to perform practically continuous service, suggesting the propriety of comparing electric and steam operation on the basis of ton miles per annum each is able to make and also the relative weight on driving wheels and not as to their total weight.

Operating Efficiency of Steam Locomotive Limited By Operating and Traffic Conditions, and Not by the Locomotive.—The operating efficiency of a steam locomotive in freight service is so low, averaging about 3,000 miles per month, that it is generally thought due to limitations, *per se,* in the locomotive, whereas it is mainly due to operating and traffic conditions, which limitations would apply with equal force to the electric locomotive, so that, barring some increase in speed, the electric locomotive can make no greater mileage than its steam competitor in equivalent service, consequently its splendid ability to perform almost continuous service cannot be realized in practice for reasons aforesaid.

Let the rectangle A, B, C, D represent a day of 24 hours. The shaded area A, B, x, y that portion of the time for which



the mechanical department is responsible—22 per cent., the area x, y, q, z, the average time the locomotive is performing useful work—28 per cent.—*i. e.,* actually pulling trains, 3,000 miles per month, 100 miles per day, while the portion of the diagram bounded by q, z, C, D the period or balance of the time that the locomotive is under steam, with crew, and ready to go, and represents the time at terminal yards, side tracks and awaiting orders, etc. (50 per cent.).

It is just here that our electrical friends make the great mistake of claiming "greater capacity" for the electric locomotive over its steam equivalent. It is conceded that under electric conditions the area A, B, x, y may be reduced as much as one-half and perhaps, owing to greater speed, the area x, y, q, z may be increased, but the "lost motion" period due to traffic and operating causes will be relatively the same for both.

The percentages are from an actual three months' test on a trunk line and reported in 1904 in the A. Ry. M. M. Association by the committee on time service of locomotives.

The only cases where electric operation is commercially justified is in congested local passenger situations where the conditions closely approach a "moving sidewalk" condition, and the records show that these cases have been profitable only when a large increase in business has been realized.

Comparative Dead Weight of Steam and Electric Locomotives.—A modern Atlantic (4-4-2) type locomotive weighs, including tender, 321,620 pounds, with a maximum tractive force of 23,500 pounds. The ratio of total weight to tractive power is 13.3 to 1. The New York Central electric locomotive, with a total weight of 192,000 pounds and a tractive effort of 27,500 pounds, has a ratio of 7 to 1. The comparison is still more favorable for electric freight locomotives where the entire weight is on the driving wheels.

Electric Power Station Capacity Based on Average of Number of Trains in Service, Not the Aggregate.—The impression is quite prevalent that if 100 steam locomotives are required to operate a certain division, if operated electrically, a power station capacity the equivalent of 100 locomotives would be necessary, whereas the generator capacity, barring the installation of spare units, would be of such size as to meet the average load. This average can be determined by laying down a train sheet, from which the load at any hour in the day can be seen and the peaks located.

For ordinary computations the number of trains to provide for is, approximately,

$$\frac{\text{The total train miles per hour}}{\text{Mean speed}}$$

This formula is the result of cancellation from the following:

(a) H. P. days ÷ Aggregate H. P. *i. e.,*

$$\text{(b)}\quad \frac{5{,}280 \times (\text{Dis. miles}) \times (\text{No. trains}) \times (\text{Tons}) \times R}{47{,}520{,}000 \text{ ft. lbs. in 1 day}} \div \frac{\text{Tons} \times R \times \text{m.p.h.}}{375}$$

R = resistance due to gravity, plus resistance due to speed, plus curve resistance.

Transposing and cancelling:

$$\text{(c)}\quad \frac{\text{Dis. miles} \times \text{No. trains}}{24 \times \text{m.p.h.}} = \text{No. trains to provide for.}$$

For illustration take a typical case:—

Distance 183 miles.

Load { 37 Freight Trains at 15 m.p.h.
22 Expresses at 50 m.p.h.
21 Locals at 30 m.p.h.
80 Trains total.

Average speed	37 × 15 m.p.h.	=	555
	22 × 50 m.p.h.	=	1,100
	21 × 30 m.p.h.	=	630
	80		2,285

2,285 ÷ 80 = 28 average m. p. h.

$$\frac{80 \text{ trains} \times 183 \text{ miles}}{24 \text{ hrs.} \times 28 \text{ m.p.h.}} = 22 \text{ trains.}$$

For more accurate work a train sheet should be made either with miles as ordinates and time as abscissæ, or one with trains as ordinates on a time (abscissa) base.

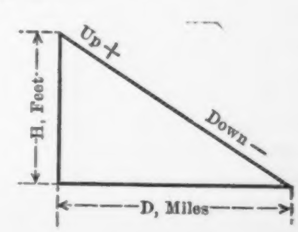
Train Resistance.—Relative to "R" (*i. e.,* resistance) for gravity; divide profile into sections, one for each change in grade plus or minus as the case may be:

$$\frac{H}{D \times 52.8} = \text{Per Cent.}$$

Each 1% grade = 20 lbs. = R.

R for curves 0.56 lbs. per degree.

$$\text{R for level sections} = 2 \text{ plus } \frac{\text{m.p.h.}}{4}$$



From Power House Viewpoint, More Economical to have Many Trains than to have Same Tonnage in a Few Heavy Trains.—Consider the example of a road or division 100 miles long on which a given train requires 2,000 horse-power to keep it in motion. If 20 cars take a maximum of 100 horse-power each, the electrical conductors and distributing apparatus will never be required to deliver more than 100 horse-power at any one point. If, on the other hand, the entire traffic of the line must be concentrated in a single train, the electrical conductors and distributing apparatus must deliver the full 2,000 horse-power at each and every point. In other words, with the concentrated load, the capacity of the distributing apparatus at each and every point must be 20 times as great as the capacity when 20 cars are used to give the same total load. Electric traction has proven its superiority for distributed loads, but concentrated loads are still handled almost exclusively by steam locomotives.

Electric Locomotives Efficient Where Traffic is Dense.—In the annual report of the P. R. R. (1903) the President states: "That the congested condition of your system has brought about a large increase in the ton mile cost, which for 1903 was 25 per cent. greater than for 1899. In order to prevent the increase in ton mile cost, it is necessary to move freight trains faster in places where traffic is dense, and for such purpose the electric locomotive is most efficient."

Greater Power and Overload Capacity Afforded by the Electric Locomotive.—With steam locomotives the most economical average speed, for freight service, is 12 to 15 miles per hour, where there is ample track space for the free movement of trains. With a dense traffic this free movement can only be obtained by a higher speed, and if the large train tonnage be maintained, more horse-power is required of the engine and boiler. It is difficult to increase the size of steam freight locomotives without resorting to the Mallet compound articulated type, and here we have the equivalent of two locomotives in one machine.

With the electric locomotive it is possible to develop a much greater horse-power and a large percentage of overload at the time when needed and do it more economically than with steam. The New York Central electric locomotive has a maximum peak horse-power of 3,000 which is 25 per cent. above normal. This maximum is about double the power which can be obtained from the New York Central standard Atlantic (4-4-2) type locomotive. Similar proportions can be obtained for electric freight locomotives and their size and power are not limited by boiler capacity. If the steam locomotive is capable of developing 30,000 T. F. at the drawbar at 12 m.p.h., or

$$\left(\frac{30{,}000 \times 12 \text{ m.p.h.}}{375}\right) = 960 \text{ h.p.}$$

and it is required to increase the speed of the train to 20 m.p.h. and maintain the same tonnage, then 1,600 horse-power will be required, which means the employment of a much larger locomotive or double heading.

The advantage of the overload capacity on short mountain grades or for strategic peaks is one of the strong points in favor of the electric machine and would make electric operation applicable to special cases rather than a universal substitute, in the broad light of commercial considerations.

General Conclusions.—Our conclusion, from this survey of the situation, is that the rapid development of suburban passenger traction by electricity will require large power houses at large cities and these can gradually be made sufficient for working the line on further stretches in each direction, handling congested terminals, or used where commercially practicable, until it may be desirable to electrify the entire division.

Electric operation as compared with steam shows to greatest advantage in urban and suburban passenger service. Here, if multiple unit trains are employed, so that a considerable fraction of the total weight is carried on the driving wheels, thus permitting a high rate of acceleration to be used, a schedule speed quite impracticable in steam operation can be maintained. Moreover, a more frequent service can be given without a proportional increase in expense, whilst in times of light traffic small trains can be run, the energy consumption per train in such service being almost in proportion to the number of coaches. *The law of induced travel, however, applies to urban and suburban passenger service, but does not hold for trunk lines and especially freight service.*

How to Determine Whether Expenditures for Improvements Are Justifiable.—Under trunk line conditions the only thing that interests railway managers is the traffic available at the present, relatively speaking; the future is too indefinite to be capitalized to any great degree in advance. It is more in the line of insurance companies to "capitalize expectations."

In grade revision the *authorization for expenditure* is based on the *saving in train miles capitalized.* The following is a concrete case from a western road, or rather the summation of the engineers' report as to just what the proposed rearrangement would amount to. The rate of 50 cents per train mile is to cover those items of cost directly affected by the change.

$$\left\{\begin{matrix}\text{No. of}\\ \text{trains per}\\ \text{day—7}\end{matrix}\right\} \times \left[1 - \frac{\text{1,350 tons present conditions}}{\text{1,600 tons proposed}}\right]$$

$$\times \left\{\begin{matrix}\text{Div. of}\\ \text{225}\\ \text{Miles}\end{matrix}\right\} \times \text{50c.} \times \left\{\begin{matrix}\text{365}\\ \text{days}\end{matrix}\right\} = \$45{,}990$$

Under the circumstances it will be seen that the value of 1 per cent. reduction in train mileage, per mile, per train, amounts to $1.95 per annum. The total amount capitalized at 5 per cent. equals $919,800. In some such manner the steam railroad manager arranges the proposition of the electric scheme and decides accordingly.

Results of New York Central Electrification.—In a paper before the American Society of Civil Engineers, by W. J. Wilgus, some interesting data concerning New York Central operation was given.

Cost of coal per 2,000 lbs. anthracite steam loco., terminal service....	$4,46
" " bituminous coal, road service..............................	3.12
" " " " power station..............................	2.72
Water per 1,000 gallons:—	
Power station	13½ cts.
Road service	5 "

Cost of current, when power station designed load is attained, 2.6 cents per kilowatt hour delivered at contact shoes. This includes all operating and maintenance costs, interest on the electrical investment required to produce and deliver current, depreciation, taxes, insurance and transmission losses.

Items	Operating Costs	Fixed Charges	Total
Power Station................	0.58 cts.	0.44 cts.	1.02 cts.
Transmission Losses........	0.19 cts.	0.15 cts.	0.34 cts.
Distribution Systems and Sub-Stations..................	0.32 cts.	0.92 cts.	1.24 cts.
Totals..............................	1.09 cts.	1.51 cts.	2.60 cts.

ROAD SERVICE COSTS PER 1,000 CAR TON MILES.
(Page 102, Vol. LXI, Trans. A. S. C. E.)
(Discussion by G. R. Henderson.)

	Steam	Electric
Supplies........	$2.03	$1.37
Wages....................................	0.28	0.31
Interest, depreciation, and repairs to locomotive..	0.46	0.34
	$2.77	$2.02

The item "Electric Supplies" is composed of operating expenses and fixed charges and may be analyzed thus:

53.3 kw. hour at $0.0109, $0.58 operation
52.3 kw. " " 0.0151, 0.79 fixed charges
52.3 kw. " " 0.026, 1.37

[Fixed charges = $(\frac{0.79}{1.37})$ or 57% of operating expenses.] *The brackets are ours.*

The difference in cost between steam and electric traction in road service is \$2.77 — 2.02 = \$0.75 per 1,000 car ton miles.

The fixed charges on the power plant and the transmission system are \$0.79 per 1,000 car ton miles, or about the same as the saving, so that if the train movement was but one-half the assumed amount (averaging 6,000 horse-power at the rails, or 6,000 kilowatts at the station) the cost for electric service would be slightly higher than for steam, or \$2.81 as against \$2.77 per 1,000 car ton miles.

Manhattan Elevated Results.—The Manhattan Elevated, with about 38 miles of road, was electrified at an expense of \$17,000,000. The operating ratio, under electric conditions, has been reduced from 61 to 46 per cent. of gross receipts. The net results after taking care of the increased capital, etc., *shows 15 per cent. profit, but it is a significant fact that the increase in business was 46 per cent.* (carrying about 250,000,000 people per annum 690,000 per day average, or 28,800 per hour).

Mersey Tunnel Results.—There has just been reported the four years electric operating results of the Mersey Tunnel road connecting Liverpool and Birkinhead. The net profit, allowing interest, etc., on the increased capital due to electrification, amounted to 15 per cent., but it took an increase in traffic of 55 per cent. to make this operating result possible. Ton miles increased from 43 to 67 million, or 55 per cent. Total expenses, including interest on electric capital (but not depreciation) equals 0.586 per ton mile. Interest equals \$0.106 per ton mile, or 22 per cent. of operating expenses.

President Harahan on Proposed Electrification of the Illinois Central.—President Harahan of the Illinois Central reports the results of the investigation that has been made relative to the proposed electrification in the following words:

"Our suburban traffic is the only service which would in any degree be adapted to electric operation, but even in this particular service it can be readily shown to be unjustifiable at the present time. I submit below a statement of the results which are estimated to accrue if the entire suburban service were electrified, compared with the present steam operation:

"Results of Operation of Suburban Business at Chicago for Fiscal Year ending June 30th, 1909:

Gross earnings		\$1,056,446
Operating expenses (82.9%) plus taxes		946,734
Net revenue		\$109,712

"Estimated Results Under Electrification:—

Gross earnings		\$1,056,446
Operating expenses (66%)	\$697,254	
Taxes	74,427	
		771,681
Net revenue (electric operation)		\$284,765
Net revenue (steam operation)		109,712
Increase		\$175,053
Estimated cost of electrification		\$8,000,000
Interest and depreciation 10%		800,000
Saving in operation under electrification		175,053
Deficit		\$624,947

"Our suburban traffic is not sufficiently dense to warrant the expense necessary to electrify these lines, and it is evident from the foregoing figures that even under electrification there would not be an increase in traffic sufficiently large to offset the annual loss from operation. It simply proves that under present conditions of cost of electrification of steam railways, where it means a replacement of a plant already installed, and serving the purpose, it is not justifiable to electrify either in whole or in part your Chicago terminals at this time."

The suburban district of the Illinois Central covers about 50 miles of road and carries in round numbers 15,000,000 suburban passengers per annum, or an average of 41,150 per day, or 1,700 per hour. *An increase of 100 per cent. in earnings would not enable the road to break even.*

The Railway Age Gazette, in commenting editorially on Mr. Harahan's statement, says:

"It may be accepted as conclusively demonstrated that the New York Central and the New Haven roads are moving trains by electricity more economically than they moved them by steam, in their suburban district. To enable this to be brought about, however, extremely heavy capital costs had to be assumed and the charges on these capital costs make the entire operating cost, including overhead charge, far higher than it used to be in the days of steam operation.

"For example, a standard express train of eight cars on the New Haven road pulls out of Grand Central station headed by two half unit electric locomotives, each of which cost very nearly \$40,000. The capital cost of the motive power of this train is in excess of \$75,000 (the interest and depreciation amounting to \$20 per day)—the brackets are ours. The cost of motive power at the head of a similar New York Central passenger train operated by electricity is about one-half this sum. Moreover, it will be recalled that Mr. Wilgus estimated that the direct costs of electrical equipment represented only one-fourth of the total charges attendant upon electricity. The cost of making everything ready and safe for this kind of operation is far greater than the highest estimates are apt to contemplate."

Boston & Albany Electrification.—From a report of the Electrical Commission of the State of Massachusetts the following extracts are taken (letter of C. S. Mellen, president of the New Haven road):

"We believe we are warranted in saying that our electric installation is a success from the standpoint of handling the business in question efficiently and with reasonable satisfaction, and we believe we have arrived at the point where we can truthfully say that the interruptions to our service are no greater, nor more frequent, than was the case when steam was in use. *But we are not prepared to state that there is any economy in the substitution of electrical traction for steam; on the contrary, we believe the expense is very much greater.*"

The Boston & Albany Railroad Company reports the result of their study and estimates the requirements as follows: A power station of 6,000 kilowatts will be necessary, with storage batteries to handle the peak load. The total cost of the installation is estimated at \$4,000,000, and the interest, taxes and depreciation at 9 per cent., or about \$400,000 per annum. A stock argument for electric operation is the saving to be made in operating expenses, but concerning this the following statement is made:

"Some slight economies would accrue in the transportation expenses under this operation which would be substantially absorbed by the additional expenses to be incurred for the maintenance of the additional apparatus installed and the net economies would be so small as to be inappreciable in the consideration."

Another stock argument of the advocates of electric locomotives is the growth of traffic which is supposed to result from electric operation. This argument is met as follows in the report:

"Considering now the possibilities of increasing the traffic, the statistics of the B. & A. R. R. show substantially the following number of passengers handled in the above territory per annum:

1891	4,552,918	1899	3,897,364
1894	4,799,578	1907	4,435,841

"The absence of any material increase in traffic is probably due to the fact that the circuit is occupied as a high class residential district not susceptible of rapid subdivision of property, and more particularly to the fact that suburban lines are being rapidly extended into all such outlying districts and afford a more advantageous means of collecting and distributing local travel through the commercial and residential districts than could possibly be afforded by a railroad constructed and operated upon private right of way and devoted largely to long haul operations."

Illustration Showing How to Determine Whether Steam or Electrical Operation is Best Suited for a Given Set of Conditions

The following illustration representing a concrete case is selected because of its elementary character, more especially as

the case is so simple that all the variables effecting the comparison are eliminated and the amount of coal to perform the operation is directly known: Conditions, 1,600 tons, trailing load; average grade, 1.3 per cent.; distance, 8 miles; speed, 15 m. p. h. for electric and 14 m. p. h. for steam locomotive.

(a) Electric.

1,600 net tons	
190 Loco. (2) tons	
1,790 gross tons	

R = { 1.3% grade × 20 = 26 lbs.; 5° curves 3 lbs.; Level 6 lbs.

$$\frac{\text{(Gross tons} \times \text{R} \times \text{Distance}}{500} = \text{kw. hours at the rail}$$

Substituting values:

$$\frac{1{,}790 \times 35 \times 8}{500} = 1{,}000 \text{ kw. hours (at rail).}$$

Equivalent kw. load at power house =

$$\frac{\text{Tons} \times \text{R} \times \text{m.p.h.}}{500 \times \text{Eff. per cent.}}$$

Where the efficiency between rail and generators equals 65%, substituting as before:

$$\frac{1{,}790 \times 35 \times 15}{500 \times 65\%} = 2{,}900 \text{ kw.}$$

For this particular case current can be purchased from an adjacent power house at the very low rate of 1 ct. per kw. hr. at the rail.

At this rate the power cost per trip will be 1,000 kw. at 1c., $10.00.

(b) Under steam conditions we have the same as before, 1,600 net tons plus weight of 2 locomotives, 300, or 1,900 gross tons.

The coal consumption for this particular run is 6,000 lbs.

The price per ton to equal the electric cost for power, is:

$$\frac{6{,}000 \text{ lbs.} \times \text{price per ton}}{2{,}000} = \$10.00$$

Transposing:

$$\frac{2{,}000 \times 10}{6{,}000} = \$3.33$$

But as coal for this particular case costs the road $1.70 per ton, the relative cost, coal against power, is

$$\frac{6{,}000 \times 1.70}{2{,}000} = \$5.10$$

There is a difference in ton mile hours, in favor of the electric locomotive, due to speed and reduced gross tonnage, as follows:

$$\text{1st. Electric } \frac{1{,}790 \times 8 \times 8}{15} = 7{,}640 \text{ Gross T. M. hours}$$

$$\text{2nd. Steam } \frac{1{,}900 \times 8 \times 8}{14} = 8{,}690 \text{ Gross T. M. hours}$$

To make the comparison correct the coal consumption of the steam locomotive should be proportioned on the T. M. hours produced, and the cost of coal then becomes:

$$\frac{\$5.10 \times 8{,}690}{7{,}640} = \$5.80$$

Adding to the foregoing the other operating costs the relative expense becomes:

(a) Electric.	Power	$10.00
	Lubrication, supplies, repairs, crew at $0.1158 per 1,000 ton miles, or $\frac{0.1158 \times 1{,}790 \times 8}{1{,}000}$ = ...	1.66
	Interest and depreciation, taxes, ins., etc., at 10%...	1.46
		$13.12
(b) Steam.	Coal as above....................................	$5.80
	Lubrication, supplies, water, repairs, enginemen at 25 cts. per 1,000 ton miles, $\frac{\$0.25 \times 1{,}900 \times 8 \text{ miles}}{1{,}000}$ = ...	3.80
	Interest and depreciation at 10% (2 locomotives) $\frac{\$34{,}000 \times 10\% \times 8}{365 \times 24 \times 14}$ = ...	.22
		$9.82

Cost per trip in favor of steam, $3.30, or 25% less.

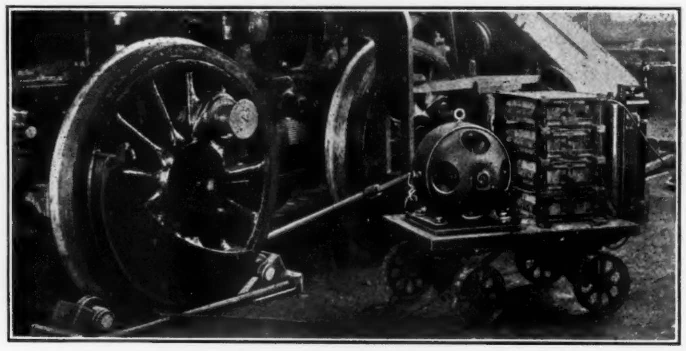
* * *

The idea is all too prevalent with the public, and even with some of the bodies that have been given legal power of supervision over railway companies, that any expenditure which can be forced upon the railway companies is just so much gain for the public. Never was there a more absolute fallacy. In the long run, the cost of every bit of railway improvement must be paid for by those who buy tickets and ship freight. Economy in the administration of our railways is just as important in the interest of the general public as if the railways were actually under government ownership.

ELECTRIC VALVE SETTING MACHINE.

A 7 h.p. electric motor, mounted on a small cart together with the resistance grids and controller, connected through a shaft with two universal joints and a sliding joint to the driving mechanism of a valve setting machine, is shown in the accompanying illustration. This arrangement is in use at the Collinwood shops of the Lake Shore & Michigan Southern Railroad. This electric drive obtains its current through a flexible cable from the socket for portable lights between the pits and is quickly and easily connected to the valve setting machine.

A driving mechanism of this kind has many advantages for use in a shop. It permits a very delicate and accurate movement of the wheel; controlled by a man on the floor who, part of the time, can watch the points of the tram. It also permits of a large variation in speed and has an absolutely positive drive. Another advantage, in many places, is the saving in air. Where electric power is available it is cheaper as a source of energy than the compressed air if the compressors are working to their maximum capacity, as is usually the case in large shops.



ELECTRIC DRIVEN VALVE SETTING MACHINE.

ELECTRIC VS. OXY-ACETYLENE WELDING.

The following notes are taken from an article in the *Electro-Chemical and Metallurgical Industry:*

It has been stated that electric welding is more efficient and economical for most purposes than oxy-acetylene welding. This is, however, not strictly correct. The first cost of an electric welding apparatus is incomparably greater than that of an oxy-acetylene welding apparatus. It is also far less portable, and its scope is consequently more restricted. There are certain applications for which electric welding may be more suitable, but for ordinary every-day work there can be no doubt that the oxy-acetylene system is much to be preferred for the following reasons, apart from the question of cost:

In welding with the electric arc heat must of necessity be concentrated upon one point, viz.: that to which the temperature of the arc is imparted. In oxy-acetylene welding, on the other hand, the heat can be brought to bear at will on the surrounding material. The correct welding temperature can thus be gradually attained at any desired point. In electric welding any unsteadiness of the hand will at once strike the arc between the two carbon points, and will thus cause an addition of fused material to the bulk of metal where it is not required. In the oxy-acetylene process material can be gradually built up as desired exactly on the part to which the flame is being directed.

In electric welding the arc is formed at the expense of atmospheric oxygen, and this fact indicates that chemical changes of an oxidizing character must take place in the welded part. In oxy-acetylene welding the welded part is surrounded by a shield of hydrogen, which tends to isolate atmospheric oxygen from the part being welded.

In electric welding a fairly stout iron wire must of necessity be used to serve as a pole of the electric arc, whereas in oxy-acetylene welding thin wires can be employed, and these are found by experience to be most suitable for the work.

In electric welding the size of the drop of fused metal added in building up the weld is not within the control of the welder to anything like the extent it is in the case of the oxy-acetylene welder.

Finally—and this is perhaps the most important point of all—in electric welding the subsequent treatment of the welded place, such as gradual annealing of the area surrounding the weld, is impossible. In oxy-acetylene welding this can be done with ease and, as already pointed out, it is just this subsequent treatment of the welded part with a view to removing internal strains and depriving the weld of its hard and brittle character, which forms the special merit of oxy-acetylene welding in large and restrained structures, such as boiler flues and similar apparatus where homogenity of the metal is a matter of utmost importance.

As illustrating the relative efficiency of oxy-acetylene and electric welding, it is of interest here to quote tests published by Mr. Ruck-Keene, the principal engineer surveyor of Lloyds, in an instructive paper read by him before the members of the Institute of Marine Engineers on September 28, 1907. The material operated upon was in each case the same, and it is important to note that while in the case of electric welding the ultimate tensile strength is somewhat greater than that obtained by oxy-acetylene welding, the ductility of the metal in the latter case is considerably better. The tests are, however, of chief importance as indicating the value of annealing.

OXY-ACETYLENE WELDING

	Bre'dth	Thick-ness	Area	Tons Total	Tons per sq"	Extension in 4 Ins. per cent.
	Inches	Inches	Inches			
Not annealed.....	1.5	.62	.93	22.85	24.5	30 } Solid Plate
Annealed...........	1.5	.62	.93	22.35	24.0	36 }
						Extension in 8 Ins. per cent.
Not annealed.....	1.5	.62	.93	22 9	24.6	28 } Broke away
Annealed...........	1.5	.63	.945	22.1	23.3	29 } from the weld.

COLD BENDS.

Not annealed....................180°
Annealed....................180°

ELECTRIC WELDING

	Bre'dth	Thick-ness	Area	Tons Total	Tons per sq"	Extension in 4 Ins. per cent.
	Inches					
Not annealed......	1.0	.56	.56	15.35	27.4	12 } Broke
Annealed...........	1.0	.55	.55	14.5	26.3	14 } through weld.

COLD BENDS.

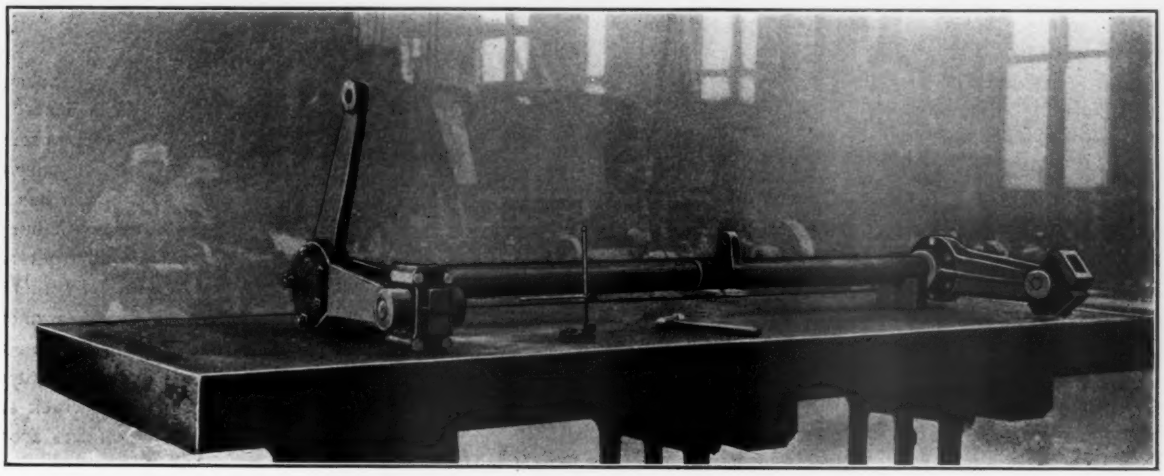
Not annealed (showed signs of fracture at weld)....................58°
Annealed ....100°

INCREASE IN MILEAGE DURING 1909.—During the past year 3,748 miles of railway, not including electric railway, have been built in this country. During the previous year 3,214 miles were built.

FACE PLATE FOR TESTING VALVE GEAR.

In order to be sure that the valve gear, which has undergone repairs and is ready to be applied to the locomotive, is properly aligned, a face plate of ample dimensions has been installed in the Collinwood shops of the Lake Shore & Michigan Southern Railway. This plate, mounted at a convenient height in the valve gear assembling section of the shop, is shown in the illustration and all parts of every valve gear, which require such testing, as for instance, the reverse shaft, rocker arms and links, are put upon it and tested for accuracy of alignment and dimension before being applied to any locomotive.

Experience with this arrangement soon proved its value, as it has been found almost impossible to previously locate with accuracy the arms of a reverse shaft which had undergone repairs, or of the trunnions of the link and other parts. Inaccuracy at these points not only often causes a great deal of trouble in properly setting the valves, if in fact they can be properly set at all, but it also tends to aggravate itself the longer the engine is in service and causes constant trouble with the valve setting and general operation of the locomotive.



FACE PLATE FOR TESTING VALVE GEAR—COLLINWOOD SHOPS.

The plate can of course be used for general work when not required for valve gear and on account of its size has proven to be a great convenience.

TUNGSTEN LAMPS ECONOMICAL.—One tungsten lamp will replace five 16 candle-power lamps, giving the same candle-power, 80, and save in one thousand hours' service 180 kw. hours. The list price is $1.00 for five 16 candle-power lamps, and $1.60 for the tungsten—a list difference of 60 cents or a net difference of 48 cents. If we divide the saving, 180 kw. hours, into this difference in cost, we can readily find out at what price per kw. hour it will qualify, thus: 48 ÷ 180 kw. hrs. = 0.26, or, say, ¼ cent per kw. hour. Above this rate the tungsten lamp begins to return a saving. If we have a rate at 10 cents per kw. hour, the one hundred and eighty hours' saving has a value of $18.00. With a 32 candle-power 40-watt tungsten costing $0.90, the saving over two 16 candle-power carbon lamps is 72 kw. hours, and the additional list cost is 63 cents, therefore the 40-watt tungsten lamp saves its additional cost at about 6/10 cent per kw. hour and above. It is clear, therefore, that these lamps will pay their cost several times over at ordinary central station rates, and they are very economical lamps to use. The life performance is very good. It gives a life averaging eight hundred hours or more, with practically undimmed candle-power. The deterioration is not over 10 per cent., and, owing to the high brilliancy, the change in candle-power is not noticeable, so that the life of the lamp is actually its total life. The blackening effect in 800 hours is practically nil.—*F. W. Willcox before The Engineers' Club of Philadelphia.*

LOCOMOTIVE TERMINALS.

A DISCUSSION OF THE ARRANGEMENT, DESIGN, CONSTRUCTION AND OPERATION OF LOCOMOTIVE TERMINAL FACILITIES TO OBTAIN THE GREATEST EFFICIENCY.

Part II.

Cinder Pits

Location.—The cinder pits, as mentioned in the discussion of the track arrangement, are customarily located on a direct line between the coal chute and turntable and as close to the table as possible. As it is sometimes necessary to raise the grade of the cinder pit in order to obtain good drainage the distance from a pit to the table in such a case should be great enough so that there will not be trouble with engines running away and getting into the turntable pit. On the Pennsylvania and a few other roads it is believed that fires can be more easily cleaned when the tender is empty and the delay at the coal chute is not long enough to cause any damage, so the cinder pits are located ahead of the coal chutes. Long experience has not developed any objections to this arrangement.

The best type of cinder pit depends upon the number of locomotives handled in 24 hours, the drainage facilities, the amount of ground area available and the climate. There are two general types, *i. e.,* hand operated and mechanical; the latter including arrangements whereby the cinders are discharged into buckets that are hoisted and dumped by different methods: the clam shell loader operated by a locomotive crane and the traveling conveyor. Each of these are in successful operation at various points in the country, but in the great majority of cases the hand operated cinder pit is employed and this in most cases will probably be found to be satisfactory. Special circumstances often make it impossible or inadvisable to use the hand operated cinder pit where the general features appear favorable to it, and hence like all other features in connection with the terminal the decision must rest upon the conditions at each individual point.

One of the most successful mechanically operated cinder pits is the type used on the Pennsylvania Railroad, where a narrow gauge track is set in the bottom of the pit and special buckets are carried by small cars, which run on this track. These are placed underneath the ash pan openings and after the fire is cleaned and the locomotive has moved off the pit they are pushed to a central point where the buckets are hoisted by an air cylinder on a transverse trolley, or in case of large terminals by a traveling crane and carried over the top of the cinder car setting on a track at grade, where they are dumped automatically. This arrangement was very fully illustrated and described on page 46 of the February, 1906, issue of this journal.

SYNOPSIS.

At points where a locomotive crane is used for coaling or other purposes in the vicinity, and it has not enough work to keep it busy all of the time a cinder pit arranged to be cleared by this method is found very economical and satisfactory. In such cases the part of the pit underneath the running track is sloped so that the cinders are discharged into a depressed basin that is usually partially filled with water and is of a size sufficient to hold a day's collection. The cinders are loaded by means of a clam shell or orange peel bucket operated by the crane, when it is available, upon cinder cars standing on a parallel track.

Size.—This factor is dependent upon the maximum number of locomotives which it is desirable to handle per hour and will usually be made larger than is required for average conditions. A long delay at the cinder pit is often responsible for a large part of the trouble with leaky boilers. The delay is, of course, dependent upon the number of locomotives that can be handled upon the pit at one time and the number of men provided for cleaning fires, rather than upon the speed at which the ashes and cinders can be cleaned from the pit. There are cases, of course, where with a hand operated cinder pit it would be impossible to keep all of the pit cleared for use, because of the steady and constant stream of locomotives passing over it. The condition, however, is not very general and following a rush of power over the pit, there will usually come slack times when it can be cleared and there will be as a general rule small probability of delay by the pit being filled with cinders. Hence where the layout, cost of ground, drainage and labor conditions will permit it will probably be found most satisfactory to install a hand oper-

ated cinder pit of sufficient length to accommodate a rush of locomotives, so that they can be passed on to the turntable with an average delay of not to exceed five minutes or at the rate of twelve per hour. Since it takes in most cases on an average of about thirty minutes to clean the fires and ash pans of large locomotives, this means that the pits must be of a size, and a sufficient number of men employed, to clean six locomotives simultaneously. The usual arrangement will be two parallel pits each holding three locomotives, or about 200 ft. in length. In addition to these there should be a small cinder pit suitable for one locomotive, or about 30 ft. in length, on each of the outgoing tracks.

Construction.—With the mechanically operated cinder pits, the construction, of course, is determined by the type and arrangement.

GOOD DESIGN OF HAND OPERATED CINDER PIT.

With the hand operated pit it is almost universally arranged to open on to a depressed track on which the cinder cars are stored. This construction has passed through several stages of evolution and is now almost standard. The inner rail is carried on a row of cast iron columns and the outer rail either by similar columns, or the wall of the pit. The floor of the pit is usually extended about 2 ft. beyond the rail to form a platform from which the men can shovel and also to prevent the cinders from dropping into the depressed section. The older arrangement was always to have the outer rail on the wall of the pit, but it has been found that with wide firebox locomotives it is preferable to carry it on a row of columns and set the wall back some distance, so that the water will not collect on the outside and the men can have a better footing for poking out the ashes in the pan. This also increases the storage capacity of the pit somewhat and is considered with favor where it has been used for some time. One of the illustrations shows a pit arranged in this manner and a drawing is also given showing the construction of the chair or column supporting the rails.

The depressed track should be set sufficiently deep to have the top of the cinder cars not more than 2 ft. above the level of the shoveling platform. This, of course, is sometimes impossible because of drainage conditions, but should be so arranged if conditions will permit. It is preferable, of course, to have the top of the cars come on a level with the platform, which will allow the use of aprons and prevent the dropping of cinders down into the pit. In a very few cases it has been possible to obtain the room and the proper drainage to so arrange a cinder pit that when the ash pans are emptied, cinders will slide down an incline and into the cars. This, of course, eliminates all shoveling and is an almost ideal condition, which unfortunately cannot be used at very many terminals, as usually, if the drainage is suitable, there is no room permitted for the long incline necessary to get the required depth.

While most of the modern pits are made with concrete walls and floors it has been found that this material in the latter place disintegrates after two or three years from the action of hot cinders and cold water. Recognizing this condition a committee of the Bridge and Building Association recommends that hard burnt brick or fire brick be used for the floors and shoveling platform of the pits. The brick when worn out can easily be renewed with comparatively slight expense and they stand the service better than a concrete floor.

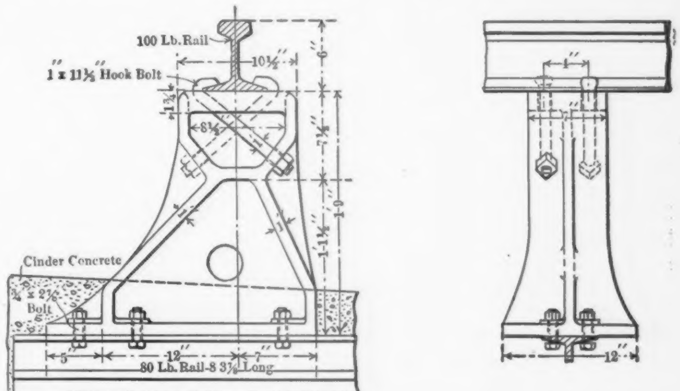
A guard on the inner surface of the shoveling platform, which will permit drainage but is high enough to keep the cinders from rolling off the edge, is advocated by many engine house foremen. This is also an advantage in that it gives something for the workmen to shovel against on that side of the platform.

Water Supply.—The water supply should be ample and convenient and it has been found that a 2-in. water main for each ash pit, having a hydrant about 25 ft. from each end of the pit and others not more than 50 ft. apart, spaced equally distant between these two, is very satisfactory. These hydrants should be so located and of a design that will not interfere with the workmen, and not be subject to injury by the tools that are thrown around. Numerous hydrants permit short sections of hose, which are economical in every way.

A high pressure steam line should also be provided at each ash pit with hydrants arranged the same as for the water. This main should be thoroughly insulated and the valves kept in good condition.

Shelter.—A tightly built shelter located in a convenient place and provided with heating facilities should in all cases be furnished in connection with the cinder pits in cold climates. The lockers and wash room for the cinder pit men should be in the same building and a desk provided for making out reports. The terminal telephone line should have a connection in this building.

Design of Locomotive.—In view of the fact that it is generally recognized that the cinder pit is in many ways one of the most important features of a satisfactory locomotive terminal, it is surprising how little attention was given up to very recent years to the design of the locomotive to facilitate the work at this point. The arrangement of the grates, their shaking connections and of the ash pans control the time that it takes to either clean or dump the fire and the ash pan. Everything that is to be operated by the men at this point should be of the strongest and most substantial construction in every particular. The engines are often frozen up and a coal pick is freely used to loosen up the ash pan slides or doors and the sides of the pan are pounded to loosen the frozen mass within. The time it takes to clean or dump a fire will be greatly facilitated if the grates are designed with this necessary operation in view. With a clinkering coal large dump grates at both ends of the firebox are of great assistance. Ash pan doors and operating gear should be

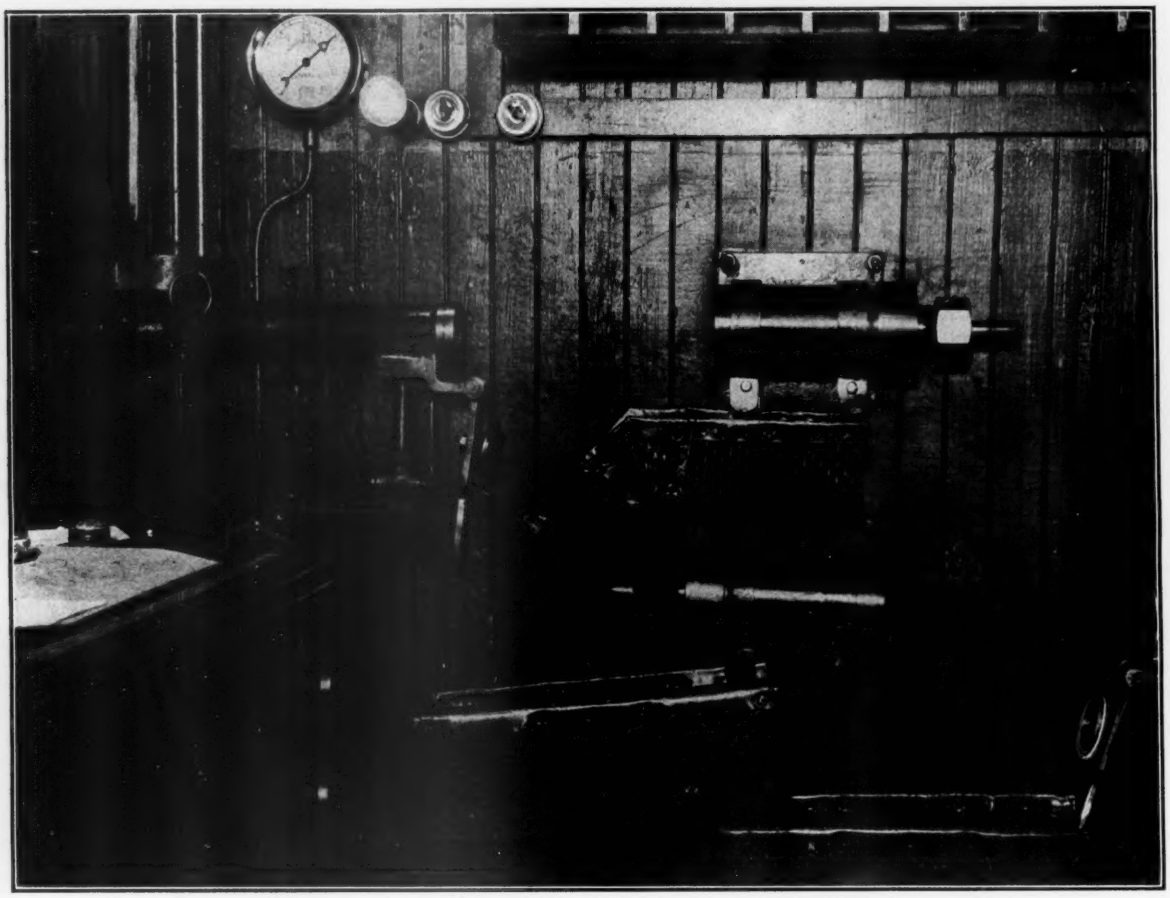


CAST IRON RAIL CHAIR FOR CINDER PITS.

designed with zero weather distinctly in mind. Shaker bars should be amply strong so that they will not be sprung and the operating levers should be so located as to have ample clearance when operated to extreme positions.

Inspection Pit

In order to be informed of the exact condition of an incoming locomotive at the earliest possible moment and thus be able to either immediately order it out again or make arrangements for quickly doing some heavy repairs, etc., it is advisable to inspect the locomotives the first thing after they reach the terminal and for this purpose at a number of the most recently constructed



END OF PNEUMATIC TUBE LINE FOR TRANSPORTING REPORTS FROM THE INSPECTION PIT. THIS VIEW SHOWS THE WORK CLERK'S DESK IN THE ENGINE HOUSE ON THE P. R. R. AT PITTSBURGH, WHERE TWO SEPARATE LINES TERMINATE.

engine houses an inspection pit is provided on the incoming tracks. It has been the custom to follow this practice at most of the division points on the Pennsylvania Railroad for a number of years and most satisfactory results are attained. At some points where severe winter weather is encountered it has been found necessary to house in the inspection pits, which can be done with little difficulty.

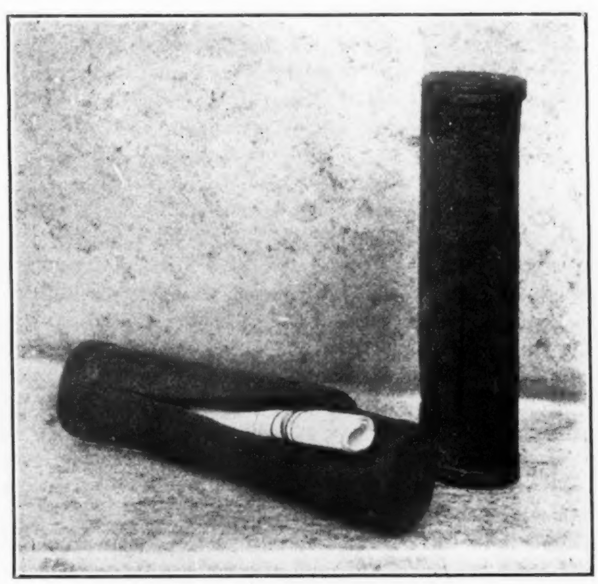
Inspecting pits should be located, preferably, at a point where the inspecting can be done before coal and water have been taken, so that in case it is found necessary to jack up the tender for repairs, orders may be issued not to take coal and water before going into the house. This location, however, is sometimes inconvenient or impossible and inspection pits are located just ahead of the cinder pit, so that a report of the repairs needed can be obtained without waiting until after the longer delay on the cinder pit.

Design.—Inspection pits are preferably constructed of concrete following very closely the design of engine house pits. They should be longer than the longest locomotive and be provided with a convenient and safe entrance and exit at one or both sides near the ends.

A shelter for the inspectors, fitted with lockers, wash-room and desks, as well as telephone, should be provided alongside of the pit.

Pneumatic Tube System.—At several points on the Pennsylvania Railroad a pneumatic tube connection is installed between the house at the inspection pit and the work clerk's office in the engine house by means of which the report of the inspectors can be put upon the work clerk's desk within a few seconds from the time they are made out and oftentimes they have reached this point before the engine has stopped at the coal chute. A device of this kind at a busy terminal cannot be praised too highly.

Several of the illustrations show part of this tube system, which consists simply of a 2-in. pipe laid in a box just below the surface of the ground, having all bends made with a large radius. The ends of this pipe are fitted with a hinged flap valve and just inside of the end is connected a small pipe from the compressed air system, having a plug cock in a convenient location. The air pressure is passed through a reducing valve and a pressure of but a few pounds is used. The fins inside the pipe are smoothed off so as not to form an obstruction and the carriers



CARRIERS FOR REPORTS OF INSPECTORS SENT TO THE ENGINE HOUSE THROUGH THE PNEUMATIC TUBE SYSTEM.

are made of pieces of old air brake hose, the two ends being plugged with wooden blocks and a leather cap secured to the outside, large enough to overlap the end of the hose. A couple of slits in the side form a self-closing flap, which will permit the

M. P. 62

140XC 4-1-09
8½ x 5½

Pennsylvania Railroad Company.

PHILADELPHIA, BALTIMORE & WASHINGTON RAILROAD COMPANY
NORTHERN CENTRAL RAILWAY COMPANY.
WEST JERSEY & SEASHORE RAILROAD COMPANY.

*Loco. No.*______ *Arrived at Terminal*______

*Train No.*______ *Division* ______ *19*___ *Arrived at Ash Pit*______

REPAIRS NEEDED	WORK DONE BY

Tools and Supplies______
Condition of Gauge Cocks______
" " Glass Water Gauge______
" " Injector "R"______
" " " "L"______
Safety Valve Lifts at______lbs.
Safety Valve Seats at______lbs.
Reservoir Pressure______lbs.
Train Line Pressure______lbs.

______*Engineer*

______*Fireman*

*Res. Pres.*______ *T. L.* "______ } *Found.*

*Res. Pres.*______ *T. L.* "______ } *Corrected to*

______*Inspector.*

______*Foreman.*

Enginemen must report on this form at the end of their trip the condition of Locomotive, Gauge Cocks, Water Gauges, Injectors and Safety Valves; also any shortage in Tools and Supplies, Reservoir and Train Line Pressures. Air Brake Inspectors must report Reservoir and Train Line Pressures they find when pump is working to full capacity, make the necessary adjustments and state what these pressures are corrected to, signing name.

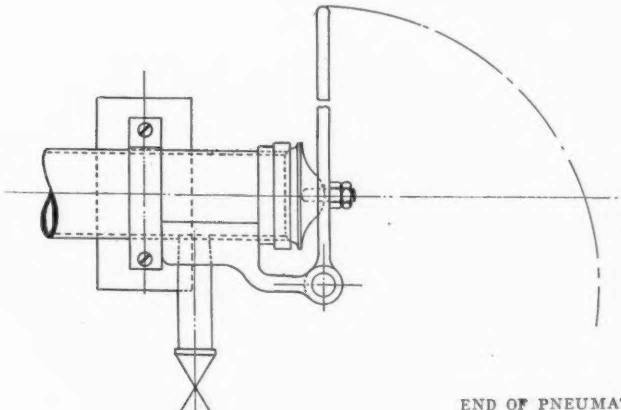
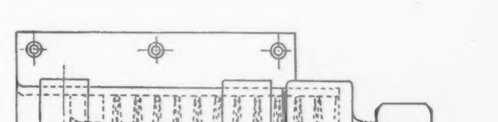
FORM USED BY ENGINEMAN AND INSPECTORS ON THE PENNSYLVANIA RAILROAD.

reports being stuck inside of the conveyor and not require any fastening.

The inspectors' reports are placed in one of these carriers, which is pushed into the end of the pipe beyond the entrance of the air supply, the hinged valve is held closed by hand, the air valve opened and the carrier will traverse several hundred feet in two or three seconds. On arriving at the opposite end it emerges from the pipe with considerable velocity and is stopped by a spring buffer, the construction of which is indicated in the illustration, and drops into a basket just below. When it reaches the work clerk's office he presses a button, which either rings a bell or lights a lamp at the opposite end to indicate that the carrier has arrived, upon which the air is turned off and the hinged valve allowed to drop. The same proceeding, of course, can be worked from either end and reports from the inspectors to the work clerk or vice versa are rapidly exchanged.

Instructions and Blanks.—While all of the better equipped roads fully realize the importance of very careful inspection of locomotives and perform this work with painstaking accuracy in most cases, the Pennsylvania Railroad at all of the larger division points has installed methods and developed an organization for doing the inspecting that is probably unexcelled in this country.

In the first place, as mentioned above, all locomotives are inspected as soon as they reach the terminal and before the engineer leaves. At a terminal handling from 100 to 150 engines per day a force of from four to six inspectors is constantly maintained and at larger points the number is increased. One of these men is paid a higher rate and is known as the "head engine inspector." The instructions giving the duties of this man are reproduced below. A second man is known as "engine inspector" and his duty covers practically all of the machinery and parts of the locomotive proper that are not covered by the head engine inspector. These duties are specified in his instructions also given below. The third man is "head air brake inspector." The fourth is known as "air brake inspector" and the fifth inspector is called "steam heat inspector." Each one of these makes out a separate report on the official form (M. P. 62), a

END OF PNEUMATIC TUBE SYSTEM SHOWING FLAP VALVE AND SPRING CUSHION.

copy of which is shown in one of the illustrations. Each of these reports is signed and dispatched to the work clerk at the foreman's office. Three to five minutes is the time that is usually required to thoroughly inspect a large locomotive.

The inspectors carry small wrenches of several sizes and such loose nuts as are found and can be tightened without delay are secured by them and not reported.

The instructions issued by the master mechanic at Pittsburgh, covering the duties of these various inspectors, are as follows:

DUTIES OF HEAD ENGINE INSPECTOR.

Examine staybolt and boiler wash tags to ascertain if engine is due or overdue for staybolt test or boiler wash and keep a book record of same. When an engine is due for staybolt test or boiler wash, it will be his duty to mark it thus. "S. B." for staybolt test and "B. W." for boiler wash on steam chest, below where it has been placed.

Examine crown and side sheets for leaks, also note condition of flues to ascertain if stopped up or leaking.

Examine and try gauge cocks to see that they are in good condition, equipped with drip pipes and of the proper length.

Examine glass water gauge and blow it out according to instructions and see that same is in good condition, and determine location of Klinger water gauge glass to see if it is in line with first gauge cock.

Examine "First Aid Box," sprinkling hose, hold down scoop while man underneath gauges same, note condition of tank brake.

Examine fire door, latch and chain.

Examine condition of apron and hearth plate to ascertain if it is properly secured and in good condition.

He will note location of throttle gland to ascertain if packing will last until engine is due for boiler wash, see if hand railing is in good condition, also see that head lights are properly secured, front and back.

When an engine is due for boiler wash, he will note if throttle or any valves in cab need packing.

Examine around the outside of engine and tender, including trucks, wheels, draft timbers, draft rigging, brake hangers, frame, brake rubbers, clogs, etc.

Examine couplers, grab irons, foot boards, steps, safety appliances, to see that they are in good condition and where open links and "S" hooks are found to report the same to be removed and replaced with solid links, see that couplers are the proper height and in good condition, this to be determined by using gauge which is provided for that purpose, also open and close knuckle to ascertain if in good working order, noting condition of knuckle pin, and gauge knuckle with gauge which is provided for that purpose.

Examine all driving wheels, flanges, tires, etc.

Examine engine truck wheels, to ascertain any defects that can be discovered from the outside.

Examine main rods and brasses, side rods and brasses, knuckle joint pins, running board and brackets, branch pipes and clamps, expansion pads of fire box.

Examine boiler braces, guide yokes, crossheads and guides.

Examine crosshead keys and note if piston shows any sign of working in crosshead.

Examine oil pipes, cups and lids.

Examine engine frame for defects such as breaks, etc.

Examine cylinders and saddles in order to locate or find any defects such as breaks or cylinder working loose on frame.

Examine and report all missing or defective safety pins, which can be discovered from the outside.

Examine blow-off cocks and riggings.

Examine valve gear of engines that are equipped with outside gear, including reverse lever reach rod, tumbling shafts, links, etc.

Examine valve gear of engines that are equipped with inside gear, including reverse lever, reach rod, tumbling shaft, rocker boxes, etc.

Examine springs and riggings of engines and tenders.

Examine cylinder cock riggings.

Examine smoke box extensions for cracks, etc., hand hold plate on same, stack and steps.

Examine wheel covers, pilot bumpers and casting back of bumper between frame.

Examine and note condition of pilot to ascertain if it is the proper height from rail and in good condition.

Examine pilot steps, feed pipes, hose and connections, overflow pipes of injectors, cab brackets.

Examine drop grate levers and make a report of all levers found that are not equipped with a standard bolt and chain.

Note if any bearings are running hot on engine and tender.

Report all missing number plates and leaky wash-out plates or plugs.

Report any defects that might come under his notice other than mentioned above.

When any of the day or night force fail to report at the proper time, it will be his duty to retain an equal number of the retiring force until such time as they can be relieved.

It will be his duty to see that all other inspectors report for duty at the appointed time, that they properly perform their duties, that the inspection building and surroundings are kept in a clean condition, that all defects are reported on M. P. 62 blanks and sent to engine house promptly, that each inspector makes out an M. P. 62 report for each engine inspected, whether defects are found or not.

Inquire of engineman as to what work he has to report on M. P. 62 (Work Report) and designate on steam chest of engine where engine is to be placed.

Any neglect of duty shall be reported immediately to engine house office by him.

ENGINE INSPECTOR.

Examine engine truck, including wheels, frame, braces, king bolt, axle or axles, boxes (noting condition of sponging).

Examine machinery underneath, including the following parts, frame, stiffening pieces, etc., driving boxes (noting condition of sponging and hard grease), shoes, wedges, pedestal caps, axles, nuts on side rod collar bolts, to see that they are properly secured, engines that are equipped with the inside valve gear, including eccentrics, straps, rods and bolts, links, hangers, transmission bars, rocker boxes and bolts, lower rocker arms and bolts, oil pipes, cups, lids, etc., also note if nuts on bolts or eccentric cranks are properly secured, of engines equipped with the outside valve gear.

Examine draft between engine and tender, including draft iron, pins, safety bars and pins, castings on front end of tenders and all castings on rear end of engine frame.

Examine tail rails, spring chambers, and buffer casting.

Examine ash pan, dampers, and riggings, grates and riggings, etc.

Examine tender underneath, including the following parts:—trucks, center casting, wheels, frame, truck side bearings, etc.

Report all missing or defective safety pins underneath both engine and tender.

Report any leaks from tank cistern.

It will be his duty to report any defects discovered in the above mentioned, and make a report of anything else that might come under his notice, not stated above.

He will report all defects discovered on M. P. 62 (Work Reports), also turn in a work report for each engine inspected whether defects are discovered or not.

HEAD AIR BRAKE INSPECTOR.

Triple valves examined, cleaned and tagged every three (3) months and at such other times when found defective.

Report engines when due for special examination of air brake, which is at the time they are due for boiler wash.

Examine brake valve, air gauge, air pump and governors (noting if air pump is properly secured).

Examine condition of air pump inlet strainers (noting date on tag of air pump, reporting them washed after 30 days from date).

Examine air pressure, all air pipes (in cab and above running board), cut out cocks, main reservoirs (when located above running board) for leaks and see that same are properly secured.

Examine sanding device.

Examine steam dome, wash-out plugs or plates, check valve flange and whistle for leaks, and all valves in cab.

He must report all missing air brake tags.

Note last date (on tag) air gauge and steam gauges were tested, and report them tested after 30 days from date.

It will be his duty to report any defects discovered in the above mentioned, and make a report of anything else that might come under his notice, not stated above.

He will report all defects on M. P. 62 (Work Reports) and make out a work report for each engine inspected whether defects are discovered or not.

AIR BRAKE INSPECTOR.

Examine all air pipes, hose and connections that are located below running board for leaks and see that they are properly secured and in good condition.

Test air gauges by placing test gauge on train pipe at rear end of tender.

Test front end of train pipe and hose by closing hose at coupling and opening stop cock in train line pipe; main reservoir pressure to be turned on at this test.

Test air signal whistle, pipes, hose and connections by putting a coupler between air and signal hose, closing cut-off cock on signal line and turning main reservoir pressure on.

Examine fulcrum bracket and connections, tank brake and driver brake piston travel, cylinders and packing leather for leaks, with brakes applied.

Examine brake rigging of engine and tender, including brake bars, connections, rubbers, clogs, hangers, pins, etc., main air reservoir, when located below running board and see that same is properly secured.

Examine condition of air pump inlet strainers when located below running board.

Gauge scoop after it has been lowered by head engine inspector, note condition of scoop and rigging, also scoop heater hose and pipe.

Report all missing or defective safety pins.

Report any defect discovered in the above mentioned and make a report of anything else that might come under his notice, not stated above.

He will report all defects discovered on M. P. 62 (Work Report) and make out a work report for each engine inspected whether defects are discovered or not.

STEAM HEAT INSPECTORS.

Examine all valves in cab.

Examine all valves at rear of tank.

Examine all governors and operate to 100 lbs. pressure.

Examine all governors for leaks and defects.

Examine all joints in cab.

Examine all surface cocks or scoop heater valves.

Examine all joints between tank and engines.

Examine all drain cocks on couplings between tank and engine.
Examine all hangers and castings between tank and engine.
Examine all clamps between tank and engine.
Examine all hose on rear of tank and front of engine, putting on a dummy or blind coupling and having 120 lbs. of steam turned on.
Examine all safety chains on rear of tank and front of engine.
Examine all pipe coverings over steam heat line complete.
Examine all pipes and connections for leaks under engine.
Examine all pipes and connections on scoop heater line, joints and clamps complete.
Examine all pipes on front and rear ends for proper position to couple.
Examine both lines to see that they are open enough to overcome freezing.

Hostlers.—It is the custom at some points to require the hostlers to clean the fires, being assisted by the cinder pit men, as needed. While this custom has some advantages in the case of a very small terminal it is not advisable at a large or busy place and if followed means that there must be as many hostlers as there are locomotives arriving at any particular half or three-quarter of an hour period during the day, otherwise there will be serious delays. The best arrangement, if conditions will allow, is to have the engineer stay with the engine until it has arrived upon the cinder pit. This, however, is seldom possible or advisable and hostlers should bring the locomotive to the ash pit and in case there are other engines waiting he should leave it there and bring others up, putting those which have the fires cleaned into the engine house as soon as the cinder pit men are through with them. This shifting from one locomotive to another will be required only at certain periods of the day or possibly but a few days in the year and under normal conditions he will stay with the locomotive while the fire is being cleaned.

The instructions issued to the hostlers by the master mechanic of the Pennsylvania Railroad at Pittsburgh are very comprehensive and are given below:

INSTRUCTIONS TO HOSTLERS AND ENGINE PREPARERS.

It will be the duty of engine preparers in taking charge of an engine at any time to first try the gauge cocks, in order to ascertain the amount of water in the boiler; then examine the crown sheet, side sheets and flues for leaks, and if any crown bolts are found leaking to immediately report same.

It will be the duty of the engine preparer, before attempting to move an engine, to know that the wheels are not blocked, no parts of the engine are down, and that no one is working about or underneath the engine. Air pump should be started, and after having the required air pressure, cylinder cocks should be opened, hand brake of tender should be released and bell sounded so as to give warning.

Engine preparers when handling an engine must move very carefully and have engine under control at all times. They should not move or shift at any time more than two engines coupled together.

Engine preparers will note the condition of grates when cleaning or drawing fires, and if grates are defective, make a report of same; also the blower must be opened just enough to take away the smoke and dust, but it must not be turned on full.

Engine preparers must see that there are at least three (3) solid gauges of water in boiler, so that it will not be necessary to operate injectors while cleaning or drawing fires.

Injectors must not be operated while engine is on the turntable.

Fires must be banked near flue sheet, so as to prevent flues from leaking.

Engines must be placed in the engine house or storage yard after the fire has been cleaned, with sufficient steam pressure and water in boiler, and the fire in such a condition that the engine will not require any attention for at least one hour after.

Engine preparers, after placing an engine in the engine house or storage yard, must see that the engine is properly secured by having reverse lever in center of quadrant, throttle closed, hand brake of tender applied, and cylinder cocks opened.

Engine preparers or fire-up men when firing up an engine must see that the boiler has the required amount of water before firing up; also see that the throttle valve is closed, reverse lever in center of quadrant, hand brake of tender applied and cylinder cocks opened.

At points where track blocks are used in storage yard, it will be the duty of the engine preparer to place blocks under wheels.

Water Crane

There should be water cranes located to serve all outgoing and incoming tracks. The location on the outgoing track should be such that an engine taking water will not interfere with one behind stopping at the outgoing cinder pit. On the incoming tracks all possible locations seem to have been tried. It is the custom at some points to take water and coal at the same stop and in the case of the multiple track coal chutes if the two operations can be performed simultaneously this is a good location for the crane. However, this combination would not be possible with a side pocket coal chute. At other points water and sand are taken at the same stop and if the operations are performed simultaneously there is no objection to doing it, and probably in most cases this will possibly be found the best location for the water crane. In fact, water, coal and sand can all be taken at one stop, if the three operations are performed simultaneously, without objection and with considerable advantage. However, if they are performed independently and successively there is serious objection to doing it at one stop.

The 12-in. water crane is now almost standard and seems to be a very satisfactory size. It is recommended by the Maintenance of Way Association that in cases where the crane is not more than 100 ft. from the tank the pipe leading to it should be of the same size as the column. At a greater distance a size larger than the column is recommended. If these conditions are fulfilled a 12-in. crane will furnish the water rapidly enough for a 5,000 or 6,000-gallon tank. The crane should be capable of being swung both from the top of the tender and from the ground and the turning on and off of the water should be controlled from both points. The arm of the crane when parallel with the track should be locked in position.

The balanced self-draining and non-freezing valves which are now available for water cranes eliminate much of the difficulty that was formerly experienced.

Drainage around the water cranes will need careful attention since more or less coal is bound to fall off the tender at this point and will cause trouble in the drains unless proper provision is made. This is sometimes done by having a removable basket in the top of the sump, which is covered by the grating and a large part of the coal that gets through the grating can easily be removed.

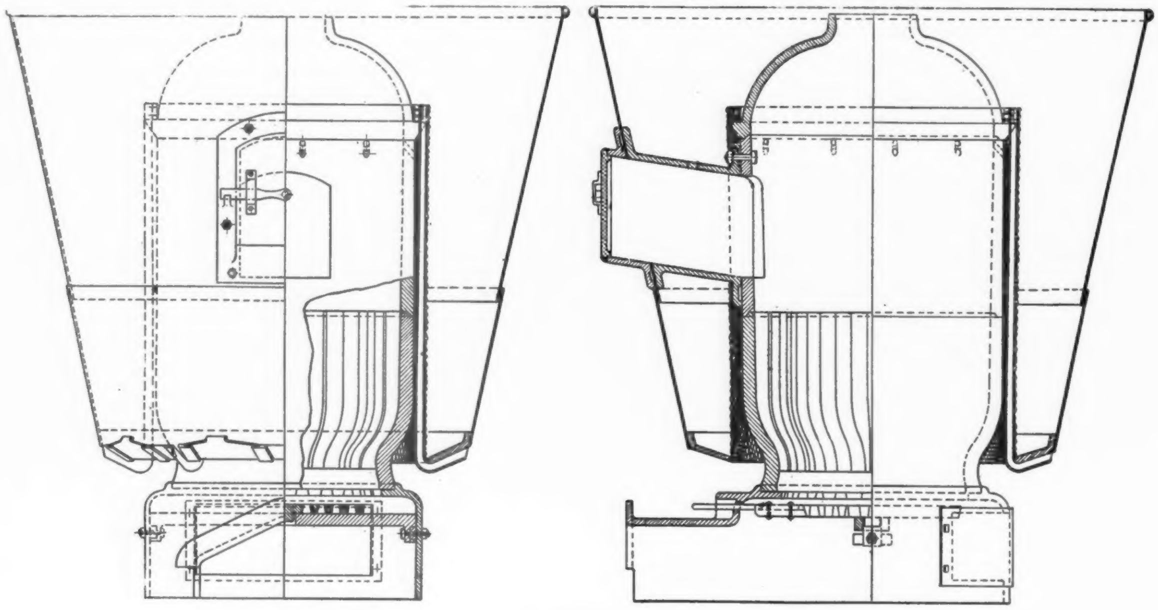
Sanding

It is almost the universal custom to dry the sand used by the locomotives at any terminal at the point where it is used, although the possibilities of having a central drying plant and shipping the dry sand is worthy of investigation and in some cases has been tried with great success.

Assuming, however, that sand is to be dried locally the construction at this point should be such that a minimum amount of manual handling will be required. Where a gravity coal chute is used it is probably best to place the sand house at the end of the chute and, if possible, ship the sand in bottom dumping cars, which can be placed over their hopper and discharged to a large wet sand bin below. This bin can be arranged to have a large storage capacity and will discharge direct to the drier without handling. At points where a trestle is not used, however, or where its location is inconvenient, if the terminal is large enough, a small, short wooden trestle can be built and the drier located below the ground level so that practically the same effect can be obtained. The advantage of such an arrangement will be greatly increased if self-dumping cars can be used, but where the sand has to be shoveled from the cars, or the terminal is small, there is no objection to the usual method of having the wet sand stored in a building alongside a spur track, provided its floor level is above the top of the sand drier and that the sand will not have to be lifted into the drier.

A number of types of driers have been suggested and used at various times, but the old cast-iron stove has maintained its place and is almost universally used. In his paper before the Railroad Club of Pittsburgh, William Elmer, master mechanic of the Pennsylvania Railroad, describes a stove and netting used on that road, that is excellent in every way. He said in part:

"It does not seem right to have the netting on the outside where the wet sand is and leave the dry sand packed around the hot stove with no way to get out but by forcing itself through layers of wet sand surrounding it. A very satisfactory arrangement is to have the netting close to the stove and separated from it by spacers, so that as fast as the sand is dried it is free to fall through. A row of holes drilled through the stove body near the upper part of this space will permit the steam to pass off through the smoke pipe. Stoves last much longer with this ar-



DESIGN OF SAND DRYING STOVE RECOMMENDED BY WILLIAM ELMER.

rangement, as the sand does not bake against the barrel and burn the section out. It has also been found very beneficial to put the stove sections on a boring mill and face the joints before erecting. This avoids the leakage of air through the joints as would be the case with rough castings. An opening at the bottom of the stove sufficiently large to take out the grate will prevent tearing down the whole arrangement when this repair must be made."

The common custom of lifting the dry sand by compressed air is most satisfactory and needs no comment other than the matter of the elbows or bends in the discharge pipe. These should be made of a very hard material and with thick walls on the outer curve. A carborundum protected metal, which it is claimed will resist the action of the sand blast, can now be obtained and would seem to be excellent material for this purpose.

The sand spout for filling the boxes should be flexible in every direction; a telescopic spout with ball joints is probably the best. The valve controlling the flow of the sand should be such that it will not be held from its seat by any small twig or other obstruction. A heavy cone-shaped valve seating against a hardened steel ring answers this purpose nicely and prevents the stream of sand from continuing to emerge from the spout after the valve has been closed. A further protection by means of a cap over the end of the spout will positively prevent any sand getting into the machinery.

Coaling Stations

There is probably a greater opportunity for improvement and saving in connection with the handling and use of fuel than in any other one thing on our railroads and, while this subject as a whole has no place in this discussion, the type of coaling station and its operation is largely dependent upon the method of keeping fuel records and of the activity of the department which has the cost of locomotive fuel in charge. In the first place, if the fuel record of the locomotives or of the engineers is carefully taken, and results are being obtained from its use, it is very essential that the amount of coal put on each tender be either weighed or measured with fair accuracy and the customary scheme of allowing a very low grade man to guess at the number of tons by the size of the pile should not be tolerated for a moment. The accurate weighing of the coal which goes on to the tender by the balancing of a scale beam is probably the most practical and this is being done with entire success at a number of coaling stations that have been in operation for several years. If the coal cannot be weighed the next best thing is calibrated pockets, which will give something approaching accuracy in the amount of coal taken by each locomotive. It has also been suggested, although so far as is known not yet tried, that the tenders be weighed before and after taking on coal. This suggestion, considered by some as being ideal in its results, presents a number of difficulties. A modification of this plan would be to equip the tender with a weighing hopper of some nature.

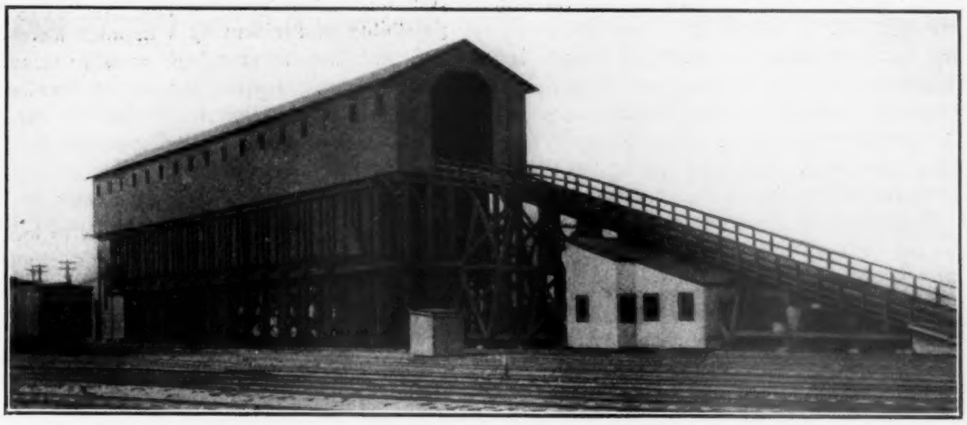
One or the other of these methods should be used at all new coaling stations, as without doubt it will not be very long before information as to the exact amount of coal used by each locomotive and each fireman will be required on practically all roads. The time when the coal chute man will not be asked to guess at the amount of coal put on is not very far in the future.

As was mentioned in connection with the discussion of the track arrangement, the shape of the plot, cost of the ground, labor conditions and steadiness of supply have a very decided influence on the type of coaling station that should be installed. There are four or five different types of mechanically operated plants now in operation, several of them numbering fifty or more different examples. There are also a number of what might be termed semi-mechanical plants in use, but by far the most numerous are the well-known trestle type, sometimes termed a gravity chute, where the cars are pushed up a long incline by a switch engine.

Each of these arrangements has points of advantage and each is in more or less successful service in a number of places. Where the ground area permits, it has been a general custom to install the trestle type of coal chute, the cars in some cases being drawn up by means of a cable. This type of plant as usually constructed, is cheaper to install, and for the first ten years at least, is cheaper to maintain than most of the strictly mechanical plants. When it is constructed of wood the fire risk is very decidedly increased, but on some roads, particularly the Pennsylvania. it has become the custom to use concrete as far as practical. The cost of operation of plants of this type is usually greater than the mechanical type, although where bottom dump cars are used there is no very decided difference. The cost of maintenance, as shown in the report of the Maintenance of Way Association, is considerably less, which, taken in connection with the decreased interest charge and the decreased cost of power, make them on the whole a less expensive chute.

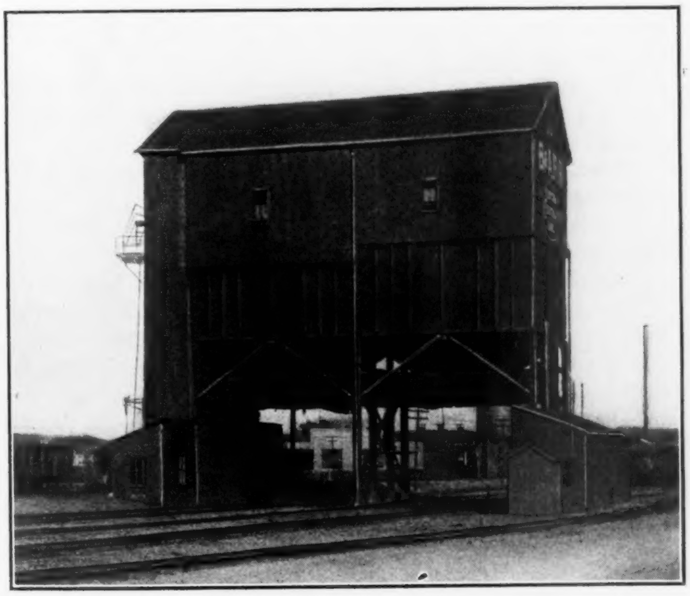
If in the case of a chute already installed it later becomes desirable to accurately weigh the amount of coal given each locomotive the side pocket gravity chute will be much more difficult to arrange. The nearest approach to accuracy with this arrangement, without actual weighing, is the calibration of the different pockets by marks on the side, showing in some manner that will not easily be obliterated, the amount in the bin at each level, the scale being in single tons. In this way a fairly accurate record can be obtained.

With the trestle type of chute of a capacity which requires



TRESTLE TYPE COAL CHUTE ON THE B. & A. R. R. AT BEACON PARK. A "GOAT" DRAWN BY A CABLE OPERATES THE CARS ON THE INCLINE.

cars to be put up with comparative frequency a mechanical pulling device of some kind is very valuable. One of the illustrations shows the trestle coal chute at Beacon Park on the Boston & Albany Railroad, which has a very steep incline, the cars being pushed up by a "goat," which runs on a narrow gauge track be-



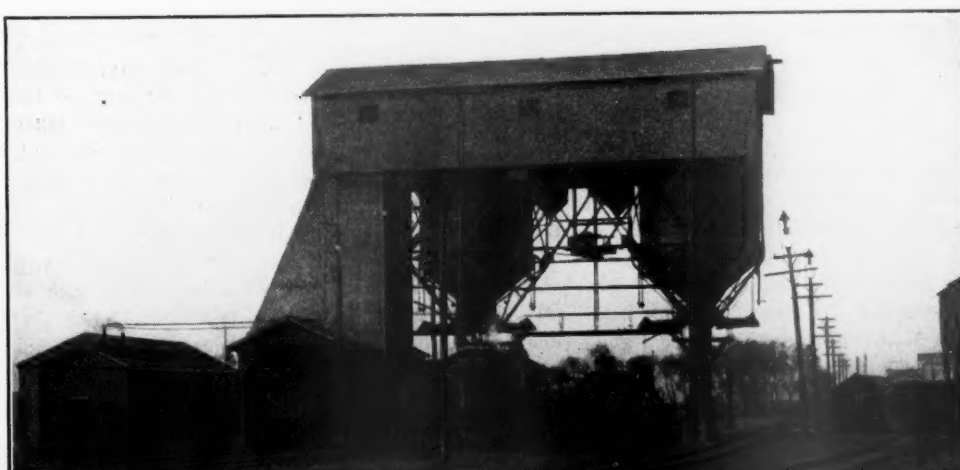
BALANCED ELEVATING BUCKET TYPE OF COALING STATION AT WEST SPRINGFIELD—B. & A. R. R.

tween the standard gauge rails and is propelled by a heavy steel cable, the motive power being an electric winch located in a house underneath the incline. This "goat," which delivers its power against the face of the coupler, is used both for pushing up loaded cars and letting down empties. A pit is provided near the end of the incline into which it drops and allows the cars to pass over it. The grade of the storage tracks is so arranged that the loaded cars when once started will, by gravity, run down past the pit so that the "goat" can draw up behind them. The empty cars, on the contrary, are switched on to another line, which has a down grade away from the pit and will run on to the siding for empties with but little assistance. The mechanical part of this plant was installed by the Fairbanks, Morse & Co. of Chicago and has proven to be entirely satisfactory in service. This chute is also provided with a small electric capstan for moving cars on the two tracks of the level section on top of the trestle.

Other schemes for drawing cars up the incline by means of a cable have also been used with more or less success. Where electric power is available an electric winch can be used for this purpose with considerable saving of ground area and eliminates the need of switch engines at times when they may not be available.

Mechanical coal plants in general have the following advantages: They permit the use of weighing hoppers, occupy decidedly less ground area, permit a more convenient track arrangement, greatly reduce the fire risk when, as is usual, they are constructed of steel, are of greater capacity and do not require the services of a switch engine. The disadvantages are the cost of maintenance, the greater possibility of interruption of service by accidents, greater breakage of the fuel and the increased first cost.

There are three different arrangements of mechanical plants in general use; one where the coal is carried up a long incline by means of a conveyor belt or a line of bucket conveyors; the second where it is elevated vertically and transported horizontally by a line of small buckets continuously operated, and the third where it is elevated and transported by two large buckets of two

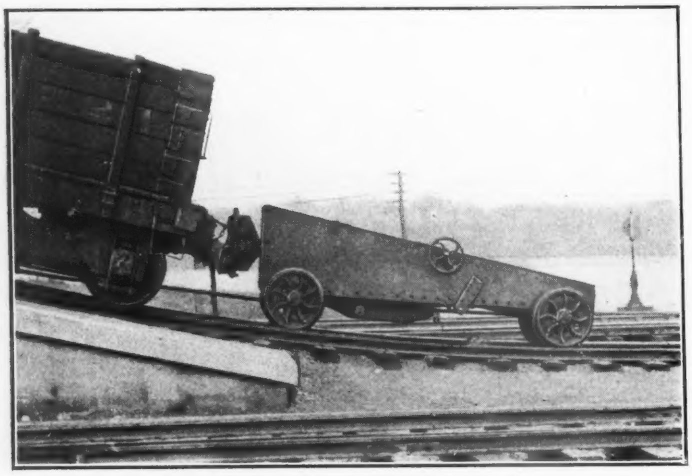


LINK BELT TYPE OF COALING STATION AT RENSSELAER—B. & A. R. R.

or more tons capacity, which are balanced one against the other and operate automatically.

An example of the first type using the conveyor buckets is in use at the East Buffalo engine house of the New York Central and was fully illustrated and described in the January, 1909, issue of this journal. An example of the second type as erected at the Boston & Albany at Rensselaer is shown in one of the illustrations and of the third type, which was installed at West Springfield on the Boston & Albany Railroad by Fairbanks, Morse & Co., is also shown. In each of these three examples the dry sand storage bins are part of the coal chute and sand is taken at the same time that the coaling is done.

Another method of coaling which has many advantages, particularly in cases where self-dumping cars are not regularly



"GOAT" USED FOR OPERATING CARS ON THE INCLINE OF COAL CHUTE AT BEACON PARK.

available for this service, is to use a locomotive crane with the clam shell bucket. The chief disadvantages of this arrangement is the delay in coaling and the impossibility of coaling more than one locomotive at a time unless more than one crane is employed, but since with suitable arrangements the coaling can be done while the fire is being cleaned the first difficulty can be overcome at many places. No elaborate structure is required, but on the other hand the storage capacity must be maintained in the cars. The depreciation on the car equipment is greater when the crane is used, but the coal can be put on the tender probably at a lower cost per ton than in any other method, everything being considered. In addition, the crane is valuable for other uses part of the time and in some cases it can be used to do all the coaling and to load the cinders as well. At points where a large storage supply is required at only certain periods of the year a locomotive crane is practically necessary and in some such cases the locomotives can be coaled directly from a stock pile and the cars released. The breakage of coal is probably less in this arrangement than in any other.

In any type of mechanical plant, except the last mentioned, bottom-dumping cars are a necessity if the cost of operation is to be equal or less than that of the gravity chute. With this class of equipment in use, in both cases, the mechanical plant can be operated with fewer men.

Details.—An important detail in any type of coaling station is the arrangement of the chute and gate. There are several good designs of these features now in use, the best being a chute that is covered at the end and directs the stream of coal downward and an under cut type of gate that shuts off the flow from the bottom upward. The angle of the chute should be arranged for easy adjustment by the operator while the flow of coal is under way and the operating platform should be where a good view of the tank can be obtained without the necessity of standing on the tender, but should be easily reached from the top of the tender. Large hand wheels operating the lifting chains from both the chute and the gate by winding drums are probably the most satisfactory.

In the case of mechanical plants spanning the tracks the steel columns supporting the hoppers should be well protected against possibility of accident by a derailed locomotive.

A pipe line carrying high pressure steam should be carried to the coal chutes for the purpose of thawing out frozen cars. At some points an electric capstan is located for conveniently handling loaded and empty cars over the hopper of mechanically operated plants.

Oil Houses

Because of fire risk it is desirable to locate the oil house separate from the other buildings. This, however, is not convenient in all cases and where the proper attention is given to safety in the storing and delivering of oil it is customarily considered good practice to locate it in a fireproof section of another building, usually the store house. Because of the danger from fire this subject has been very thoroughly threshed out and it is now the universal custom to store the oil in tanks either underground or in a fireproof basement. These tanks are arranged to be filled by gravity from the tank car through a pipe from the track or, at small storage points, from barrels through openings in the floor above.

Probably the best method of delivering is by a self-measuring hand pump which accurately records the amount of oil drawn and automatically returns all drippings. Compressed air is sometimes used for this purpose, but it has the objection of causing quite serious deterioration in the oil and sometimes interferes with the delivery at the faucet.

The conclusions of the committee on buildings before the Maintenance of Way Association cover this subject very clearly and are given below:

"When practicable, oil houses should be isolated from the other buildings at a terminal.

"Oil houses should be fireproof and the storage should be either underground or in the basement.

"Oils that are stored in sufficient quantities should be delivered at the tanks in the house direct from tank cars. For oils that are stored only in small quantities provision should be made for delivery to storage tanks from barrels by pipes through the floor.

"The delivery system from the storage tanks to the faucets should be such that the oil can be delivered quickly and measured. The delivery should also be such that there will be a minimum of dripping at the faucet and that the drippings be drained back to the storage tanks."

(*To be continued.*)

APPRENTICES ON THE D., L. & W. R. R.—The Delaware, Lackawanna & Western Railroad has decided to open a school for apprentices in the Scranton machine shops and will in due time extend the system to the shops at Buffalo and other points. The work will be in charge of the railroad branch of the Young Men's Christian Association. The students will be paid their regular wages while attending the school. Spacious rooms have been set aside for instruction purposes at the shops. Robert B. Keller will be in charge as chief supervisor and J. M. Thomas as assistant.

COST OF HEATING ELECTRIC CARS ELECTRICALLY.—In this case the heaters consumed 48.5 per cent. of the power required for operation. This proportion of power taken by the two circuits, while it would vary somewhat on different roads, owing to differences in equipment, voltage, frequency of stops and number of passengers carried is a fair average for multiple-unit trains in city service. It is not contended that these figures are by any means absolute, but they are, nevertheless, the results of tests made in actual service, and as such afford a basis for estimating the additional load placed upon the power station equipment of any Northern road during the winter months. It is apparent that an increase of approximately 50 per cent. above their normal load thrust upon the feeder stations, especially upon days when snow and sleet are putting an extra burden upon them, calls for very heavy overload capacity, or for reserve units that will add a large item of cost to the substation equipment.—*Electric Railway Journal.*

CARS AND LOCOMOTIVES BUILT IN 1909.

The number of cars and locomotives built during the past year is but a little greater than the 1908 figures, in spite of the improvement in general business conditions during 1909. However, it has really been but a few months since the railways came into the market with substantial inquiries; and deliveries on orders placed at the beginning of this movement did not begin until this fall.

Returns from 14 locomotive builders in the United States and Canada (estimating the output of two small plants) show a total of 2,887 engines. Of the 2,653 built in the United States, 2,362 were for domestic use and 291 for export. These figures include 16 electric and 119 compound locomotives. The Canadian engines, 234, were all for domestic service.

Comparisons for the last 17 years are given in the following table:

Year.	No. built.	Year.	No. built.	Year.	No. built.
1893	2,011	1899	2,475	1905	*5,491
1894	695	1900	3,153	1906	*6,952
1895	1,101	1901	3,384	1907	*7,362
1896	1,175	1902	4,070	1908	*2,342
1897	1,251	1903	5,152	1909	*2,887
1898	1,875	1904	3,441		

*Canadian output.

During the past year 53 car building companies in the United States and Canada (output of one small plant estimated) built 96,419 cars, which is 23 per cent. more than the number built in 1908. These figures include subway and elevated cars, but not street railway and interurban cars. It must be remembered also that the output of railway companies' shops is not included. Of the cars built in the United States, 84,416 were freight cars for domestic service, 2,435 freight for export, 2,599 passenger cars for domestic service and 150 passenger for export. Of the freight cars 63,763 were of steel or had steel underframes; of the passenger cars, 1,650. Canada built 6,661 freight cars for domestic service, 58 freight for export, 99 passenger cars for domestic service, and one passenger car for export. In 1908, Canada built 8,598 freight cars and 79 passenger cars.

The following table shows the cars built during the past 11 years:

Year.	Freight.	Passenger.	Total.	Year.	Freight.	Passenger.	Total.
1899	119,886	1,305	121,191	1905	165,455	2,551	*168,006
1900	115,631	1,636	117,267	1906	240,503	3,167	*243,670
1901	136,950	2,055	139,005	1907	284,188	5,457	*289,645
1902	162,599	1,948	164,547	1908	76,555	1,716	*78,271
1903	153,195	2,007	155,202	1909	93,570	2,849	*96,419
1904	60,806	2,144	62,950				

* Includes Canadian output.

—*From the Railway Age Gazette.*

CONCILIATION BETWEEN RAILWAYS AND THE PUBLIC.—The Railway Business Association, 2 Rector street, New York City, has published a booklet containing the addresses delivered at the first annual dinner, given at the Waldorf-Astoria, on November 10, 1909. These include the introductory remarks by the toastmaster, George A. Post, president of the association, and the following toasts: "The Public and the Railroads," Hon. John C. Spooner; "The Nation's Farms and National Prosperity," William C. Brown; "The Railroads and Public Approval," Edward P. Ripley; "The Equipment Industries and Railroad Prosperity," W. H. Marshall; "Public Sentiment and Railroad Legislation," Hon. William P. Hepburn.

Proceedings of the International Railroad Master Blacksmiths' Association. Seventeenth Annual Convention, held at Niagara Falls, N. Y., August, 1909. Cloth, 190 pages, 6 by 9 in. Secretary, A. L. Woodworth, Lima, Ohio.

This association is doing splendid work. Among the subjects discussed at the convention were the following: Flue welding; tools and formers; high speed steel; piece work; locomotive frame making and repairing; case hardening; ideal blacksmith shop; spring making, repairing and tempering; best materials and methods of forging motion work, etc.

RAILWAY CLUBS.

Canadian Railway Club (Montreal).—The representatives of various car lighting companies will attend the meeting on February 1, and discuss the subject of car lighting. Secretary, Jas. Powell, P. O. Box 7, St. Lambert, near Montreal.

New York Railroad Club.—At the meeting on Friday, February 18, F. A. Angier, of Galesburg, Ill., superintendent of timber preservation, C. B. & Q. R. R., will read a paper on "The Seasoning and Preservative Treatment of Wooden Cross Ties." Secretary, Harry D. Vought, 95 Liberty street, New York City.

Railroad Club of Pittsburgh.—At the meeting on February 25th, Harrington Emerson, of the Emerson Company, "Efficiency Engineers," New York City, will present a paper on the unit cost of railroad operation. Secretary, C. W. Alleman, P. & L. E. R. R., Pittsburgh, Pa.

St. Louis Railway Club.—At the next meeting, Friday, February 11th, M. L. Byers, chief engineer of the Missouri Pacific Railway, will present a paper on "An Analysis of the Natural Relations Between the State and Industrial Corporations." Secretary, B. W. Frauenthal, Union Station, St. Louis, Mo.

Western Railway Club (Chicago, Ill.).—At the meeting in February, Tuesday, the 15th, a representative of the Allis-Chalmers Company will present a paper on gas engines. Secretary, Jos. W. Taylor, 390 Old Colony Building, Chicago, Ill.

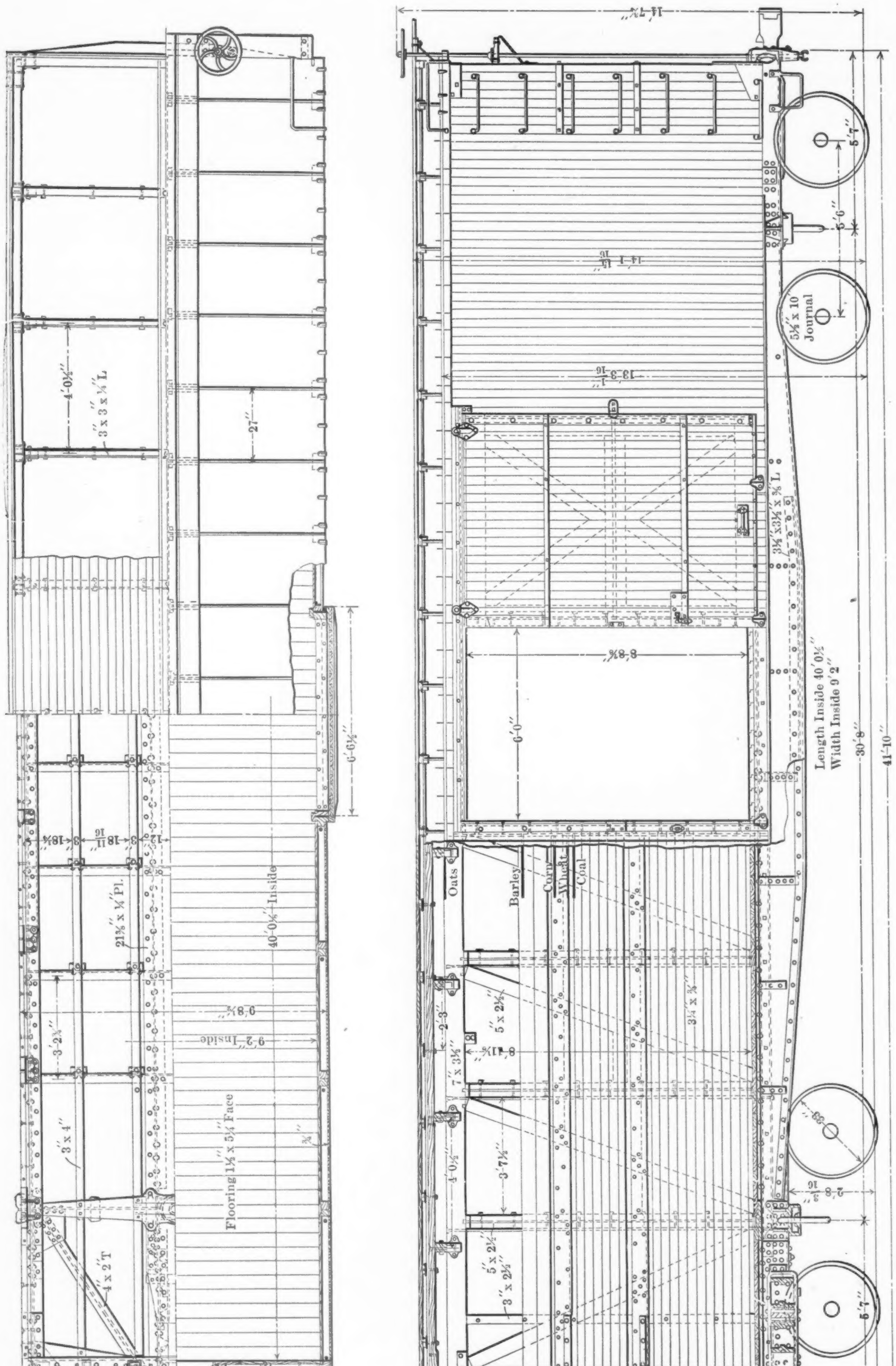
PENNSYLVANIA RAILROAD SCHOOL OF TELEGRAPHY.—Encouraged by the success attained by the graduates of its school of telegraphy at Bedford, Pa., the Pennsylvania Railroad Company has just completed the installation of additional machines for higher instruction. In addition, a library of text books on electricity in all of its branches has been opened for the benefit of the students of telegraphy. When the Bedford school was first opened, extensions of the company's own telegraph wires were run through the class room, to give the students an opportunity of handling practical railroad messages. In addition, there was installed a miniature railroad, equipped with block signals, for explaining the block signal system. The latest innovation to be placed in the school is an automatic sending machine, with a transmitter that can be set at any speed. This machine is used to teach the students to receive messages and as it transmits at a uniform speed, it is proving of great advantage. Since the Bedford School was opened in September, 1907, 234 students have been enrolled. Of this number 126 have been graduated and are now employed as telegraphers. All graduates are offered positions on the Pennsylvania Railroad.

TEMPERANCE IN SPEECH.—Talk about the homes made happy by abstinence from intoxicating drink! Why, it isn't a circumstance to the blessings that follow kindly words and acts. More hearts have been broken and greater property losses incurred as the result of ugly words than through inebriety. I propose to you as my closing thought and appeal, that here and now we launch a movement against intemperance in speech. Let those who are here, and the people everywhere, sign this pledge:

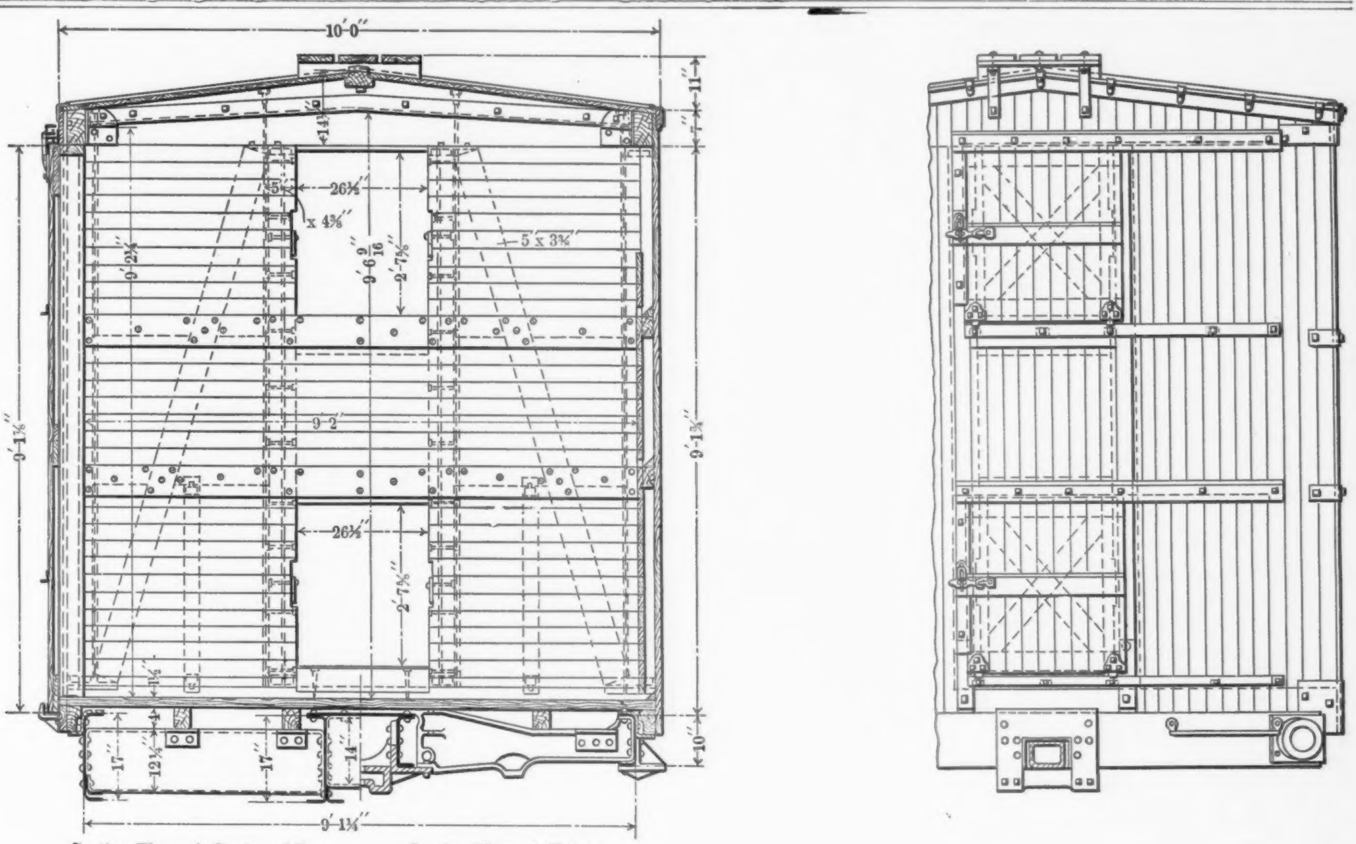
"I do solemnly promise that in the future I will abstain from the use of all intoxicating and inflammatory language."

Sign this pledge and stick to it, and the economic troubles that confront us to-day "will fold their tents like the Arabs and as silently steal away."—*George A. Post, President of the Railway Business Assn., before the Traffic Club of Pittsburgh.*

The number of passengers arriving in New York during the year 1909 by the principal trans-Atlantic steamship lines was 1,247,244, and the number leaving New York by the same lines was 482,756.



PLAN AND ELEVATION; COMMON STANDARD 50-TON BOX CAR FOR THE OREGON SHORT LINE.



Section Through Center of Car   Section Through Bolster

CROSS SECTIONS AND END ELEVATION; COMMON STANDARD 50-TON BOX CAR FOR THE OREGON SHORT LINE.

FIFTY-TON BOX CAR WITH STEEL UNDERFRAME.

OREGON SHORT LINE.

Five hundred Harriman Lines common standard fifty-ton box cars, with steel underframes, have recently been placed in service by the Oregon Short Line. This design, like those of the other common standard cars, is deserving of most careful attention, representing as it does the result of much investigation, discussion and study on the part of the Harriman Lines officials. Reference to the following table of general dimensions and data indicate that the car has an exceedingly large cubic capacity:

Length inside	40 ft. 0½ in.
Width inside	9 ft. 2 in.
Height, floor to carline	9 ft. 2½ in.
Cubic capacity	3,370 cu. ft.
Length over end sills	41 ft. 10 in.
Distance between truck centers	30 ft. 8 in.
Width over all	10 ft. 6 in.
Height from rail over running board	14 ft. 1 15/16 in.
Height from rail over brake mast	14 ft. 7¾ in.
Side door opening—clear	6 ft. by 8 ft. 8⅞ in.
Weight of each truck	8,016 lbs.
Weight of car complete	43,163 lbs.

The sills, both center and side, are of pressed steel ⅜ in. thick, 17 in. deep at the center and 10 in. deep at the bolster. They are reinforced beteen the bolsters by angles, as shown on the drawings. The center sills are covered at the top with a ¼ in. plate. The cross-bearers are pressed steel diaphragms. The pressed steel end sills are reinforced, as shown. The body bolster is of cast steel. The wooden stringers, 3x5 in., at the sides rest on Z bars riveted to the side sills; the intermediate stringers rest on the cross bearers.

The side posts consist of ½-in. iron plates sandwiched between two timbers, the three members being bolted together with ½-in. carriage bolts. The 13/16-in. pine roof is covered with Murphy galvanized iron roofing sheets, .022 in. thick. The standard trucks are used, the 33-in. wheels weighing 715 pounds each.

WATER POWER IN U. S.—The theoretical power of the streams of the United States aggregates about 230,000,000 h.p., of which about 5,250,000 h.p. is now utilized.

ELECTRIFICATION OF STEAM ROADS IN CHICAGO.

Accepting the estimate of $400,000,000 as within the mark of reason, at 5 per cent. electrification would impose an annual fixed charge of $20,000,000 direct upon the railways running into Chicago. Superimposed on the charge for track elevation and attended as it would inevitably be by an increase of from $2,000,000 to $3,000,000 in taxes on the too palpable investment, the railways of Chicago would find themselves confronted by an annual fixed charge of $25,000,000 without the shadow of a guarantee that the change from steam to electricity would reduce the cost of operation or increase their efficiency.

And here comes in the question, who would pay the price of this uneconomic, unproductive experiment? Beyond question it would eventually fall upon the business community of Chicago, through increased passenger and freight tariffs. From these there could be no relief from the Interstate Commerce Commission because the Commission would be bound to find that electrification involved dissimilar and peculiar conditions and an expenditure which justified higher rates.

But here would come the pinch. Would and could the commerce and industry of Chicago bear the burden of increased railway charges imposed by electrification? The history of civilization says that it would not. Commerce and industry seek the fields of the least resistanse in dollars and cents paid out for power and transportation. Justice would demand that the community imposing this vast burden on the railways of Chicago should pay for it. And such is the immutable nature of the laws of trade that in the end Chicago would reimburse the railways or suffer the penalty of seeing its business pass to other centers of trade unembarrassed by unremunerative restrictions on transportation.—*Slason Thompson.*

TELEGRAPH AND CABLE STATISTICS.—The total length of the telegraph and cable lines of the world is about 1,200,000 miles; the length of single wires about 4,000,000 miles; and the number of messages dispatched average about 1,250,000 per day.—*H. De B. Parsons.*